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Systematic Specific Surface Area Analyses on Rocks to Implement as a Necessary, Quick, and Informative Method to Understand Geo-Mechanical Parameter in IOR Experiments

by
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Abstract

Specific surface area (SSA) of a particle can make a major impact in understanding reservoir rock characteristics where it may indicate the possibility of fluid content. The purpose of this study is to measure and understand the SSA attribute of various rock samples from around the world. Legacy SSA measurements for carbonate and sandstone was performed using a different method, without environmental consistency and strict supervision. Moreover, this data was not adopted properly in other studies as SSA is a very niche subject that is not fully understood.

The benefits of knowing the generic SSA of a particular rock type is of great significance in understanding the main characteristics of a specific rock type and its fluid bearing potential. What is more important is understanding the variation of SSA measurements across various samples of the same lithology due to mineralogical or textural variations. However, there is a lack of published content focused around a compilation of SSA measurements and its relationship with mineralogical or texture contributing factors for even the most common rock types. In this thesis, rock samples mainly consist of chalk samples from diverse geologic locations (Denmark, Belgium, North Sea, Ireland, and etc.) that were collected for various Improved Oil Recovery (IOR) experiments. Furthermore, several types of rock samples are tested to compile an exhaustive database using a particular method at University of Stavanger (UiS) for SSA measurements (Brunauer-Emmett-Teller theory).

The SSA results for chalk samples do not vary much when compare to other rock types where high variations are found for samples that are from the same formation. There are a few parameters that can influence the SSA results and several correlations with other rock attributes are prepared to understand the dependency of these parameters. Thus, the goal of the study is to measure, evaluate, observe, and compile SSA analyses and results for several rock samples in a published form as a quick reference guide. Furthermore, the SSA will be used to calculate permeability of samples and then compared with measured permeability values.

In anticipation this study will be able to help students to have a better understanding of SSA and apply the relevant knowledge in various industrial applications. More focused research needs to be done in the future to resolve the errors and pitfalls that are faced during analyzing and understanding SSA inferred from rock samples in the laboratory versus their natural geological setting.

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Chapter 1: Introduction

In the upstream oil and gas industry, understanding and studying the uncertainties of the Earth's subsurface which produces hydrocarbon fluids always have been the focus. Various applications of computational sciences form together building blocks that are used in reducing and managing these uncertainties which includes seismic imaging, reservoir simulation, and data analytics. However by imaging the subsurface with located oil and gas fields, flow of these fluids through subsurface porous rocks are often unsatisfactory (Halsey, 2016). This known unsatisfactory nature can be assured confidence with the assistance of experimental sciences whereby specific surface area (SSA) analysis and associated measurements that are practiced in this thesis is one of them.

A key parameter to the resulting porosity and permeability of a certain rock type is grain size and fabric. Depending on the source and form of diagenesis, grain can be oriented in various ways to give us varying degrees of porosity and permeability. The fabric or orientation of a certain grain size may also result in certain extremes such as a high porosity rock with low permeability and vice versa.

The fundamental property of a rock sample such as porosity and estimating its relationship to rock type and environment of deposition has been traditionally measured either in 2D thin section analysis or various 3D fluid saturation methods. Although the results from these calculations are fit for purpose and the results depict strong reliability, the time consumed in preparation and analysis of the samples as well as the large quantity of rock samples required makes these techniques less favourable. However in comparison, indirect methods such as SSA analysis which require less sample quantity, less preparation time and the results are generally considered reliable within the bounds of certain associated assumptions.

1.1 Specific Surface Area (SSA)

Every solid material that interacts chemically or physically with their environment will undergo changes to the surface area of the material. Specific surface area of a solid varies in relation to the solid's dimensions, thus smaller particles tend to have larger specific surface area to volume ratios than do larger particles. In contrast, differences in porosities with similar dimensions in two solids have considerable influence in the interstitial specific surface areas depending on the size and number of voids (Canada Carbon, 2018). This suggested that specific surface area and porosity are the main physical properties that impact the quality and utility of a solid

material and greatly influence its performance characteristics (Intertek, 2018) in establishing their ability to behave as effective reservoir rocks or seals.

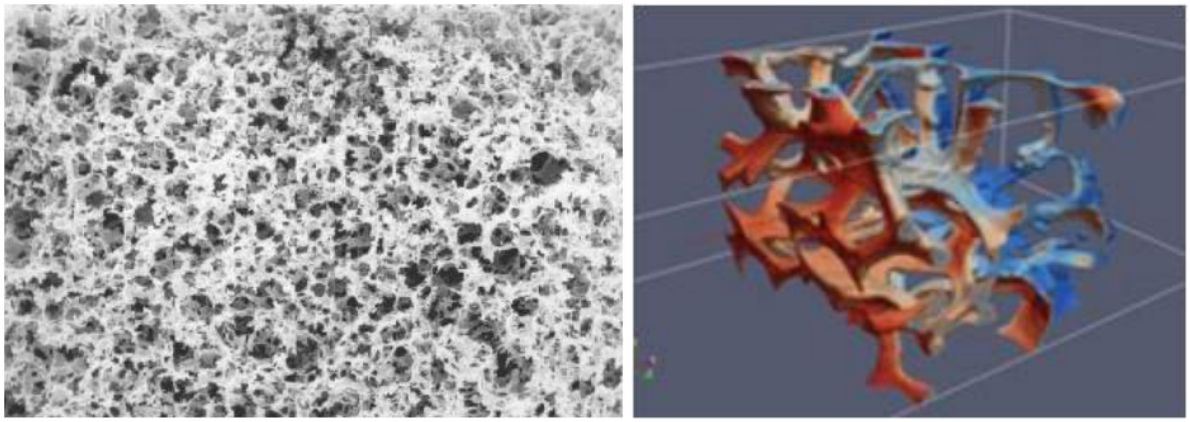


Figure 1: An example of scanning electron microscope image of a chalk sample shows porosities and void spaces in particle scale (Rezk et al., 2012) where the pore structures are roughly modelled to illustrate how pores are interconnected (Kantzas et al.). All these pore spaces are essential to determine the specific surface area of the rock sample.

Through SSA analysis, the estimation of fluid accumulation and movement through a porous rock can be calculated. Gas adsorption/desorption is a simple and commonly deployed technique in measuring the pore size and distribution of porous samples with large specific surface area while evaluating reservoir characteristics of rocks (Kantzas et al.; Liu and Chen, 2014). This method is based on capillary condensation combined with an equivalent capillary model where these capillaries are the combination of different pores in different sizes (Figure 1). The adsorbed quantity of the gas molecules at a specific pressure and temperature are used to calculate the pore size distribution (Liu and Chen, 2014).

Since gas adsorption/desorption measurements only give information on open pores, this may contribute to a drawback where the presence of the closed pores are not analysed and may cause inaccurate estimations. In other words, the particle size of the samples has to be small enough for non-enclosing pore inside the particle for gas molecules adsorption. For large-sized porous material, a little modification of its structure and texture for a slight pulverization into smaller sizes is usually employed for a better SSA analyzation (Nishi and Inagaki, 2016; Rahman et al., 2017). Quantitative microscopy is a better choice in giving the best measurement results as it can measure both the open and closed pore surface area (German, 2014), however this is not the chosen method for this study.

During gas adsorption period, lower pressure condensation occurs with smaller pore size. As gas pressure decreases, the condensed liquid will evaporate starting from larger pore spaces to the smaller ones and the adsorbed layer corresponding to the saturated vapour pressure will be

left on the pore wall. This reinstates the fact that the smaller the pore size, the lower the relative gas pressure (p/p_o) during evaporation. An adsorption isotherm from the Brunauer-Emmett-Teller (BET) equation is used in obtaining the capacity of the single gas layer (Liu and Chen, 2014). The BET plot that is produced for the SSA analysis, has a restricted range of linearity to a limited part of isotherm, which rarely extends above $p/p_o \sim 0.35$. Even though the BET model is strictly incompatible with the energetic heterogeneity exhibited by most solid surfaces, this method is still used as a standard procedure for surface area determination (Rouquerol et al., 1999).

1.2 Brunauer-Emmett-Teller (BET) Theory and Assumptions

A volumetric method is chosen and used in this research to measure the gas adsorption during the SSA analysis where BET theory is being applied. This theory of multi-molecular adsorption is able to explain the common features of gas adsorption isotherms qualitatively and give a quantitative measure of the surface area of the adsorbent where it generally predicts an adsorption to be too small at low pressure and too large in the multilayer region at pressure approaching saturation (McMillan and Teller, 1951).

It is important that a few assumptions need to be made while BET theory is being deployed to enhance the confidence in using the data acquired by this method. The most basic of these assumptions can be summarised as follows:

(i) Homogeneous Surface - BET adsorption assumes that the surface of the material is homogeneous such that adsorption occurs equally across the entire surface with no preferential sorption areas. Each adsorption site is either unoccupied or occupied with a single adsorbate molecule which it is believed that a sorption site can only dedicate one molecule. The total adsorption can then be expressed as a fractional coverage of the surface.

(ii) Limited Molecular Interactions - Once a molecule is adsorbed, it can then act as a single sorption site for another gas molecule. Other inter-molecular interactions will not be considered including interactions between gas-phase molecules, lateral interactions between adsorbed molecules, or non-sorption interactions between the gas and adsorbed phase molecules.

(iii) Kinetically Limited Process - The rate of reaction is limited by kinetic rather than diffusion constraints, and energy must be provided in the form of heat to enable the reaction to proceed. The amount of energy required is equal to the heat of adsorption on the first

surface adsorption layer, while each subsequent layer is treated as a condensed liquid and this required energy is equal to the heat of condensation, or liquefaction heat. Since each molecular layer requires the same energy for adsorption, these kinetic processes are homogeneous across the material.

(iv) Infinite Adsorption at Saturation - Once the saturation pressure is reached, the maximum number of adsorbed layers will be obtained where the material is assumed to be completely surrounded/filled by condensed liquid-phase adsorbent.

(v) Local Equilibrium - The uppermost layer, either surface-sorption sites or adsorbed molecules, is in equilibrium with the gas/vapour phase molecules. The rate of adsorption is equal to the rate of desorption, with no effect in the number of adsorbed molecules at a given vapour pressure in a saturated system (Brame and Griggs, 2016).

The above mentioned assumptions have been criticised in various forms. The first of these debates focus on the assumption that even though the energy of adsorption is very unique for the first monomolecular layer, all the successive layers is just the energy of liquefaction. An argument related to this theory states that the extension of the attractive forces emanating from the adsorbent into the successive layers as compared to the first layer are higher and cannot be ignored, thus eventually resulting in energies of adsorption greater than liquefaction energy. However if this specific change is made to the BET assumptions, the modified theory would predict values of adsorption that exceed experimental values in the multilayer region. The second debate regarding the assumption of the BET theory is that the effects of the surface tension of the adsorbate can be ignored. Although this condition is not expressly stated, it is clearly demanded by the modelled manner in which the absorbed phase enters the material i.e. the number of adsorption sites covered by a given number of molecular layers deployed. But no segregation is made whether or not continuous sites hold the same number of molecules. Although this may be preferable if a particular minimal surface energy is a key governing factor. A detail article regarding the debates mentioned can be found in “The Journal of Physical Chemistry” (McMillan and Teller, 1951).

In light of the assumptions and debates regarding the BET theory, the original BET equation will be used with a conclusion that the effects of the debated variables are ignored since they will only provide negligible confidence in the results versus documented SSA measurements.

BET equation use in this research is as shown (Brame and Griggs, 2016);

$$\frac{1}{v\left[(p_0/p)-1\right]} = \frac{c-1}{v_{\mathrm{m}}c}\left(\frac{p}{p_0}\right) + \frac{1}{v_m c}$$

Where:

p : equilibrium gas pressure

p_0 : saturation pressure of the adsorbate (nitrogen)

v : the volume of gas adsorbed at a relative pressure p_0/p

v_{m} : the volume of adsorbed gas consisting a monolayer of surface coverage

c : BET constant that indicates of the magnitude of the adsorbent/adsorbate interactions

1.3 Objectives of Study

The scope of this study can be summarized by the following objectives:

- ✓ To perform a preliminary unaided analysis of the core samples to determine lithology and important geologic features such as colour, texture, grain-size, packing, apparent porosity, etc.
- ✓ To prepare subsamples for analysis in both powder and pellet form through mechanical processes in the laboratory
- ✓ To test and evaluate some initial samples in order to qualify the method and cross analyse the results via other available equipment or vice versa so that the SSA measurements may able to be calibrated and fine-tuned prior to performing the study on the rest of the samples
- ✓ To examine and evaluate the SSA of the remainder of the samples using specialized laboratory equipment and apply calibrations
- ✓ To compile the SSA results versus rock sample types in graphical or tabulated form for cross validation and comparisons

Chapter 2: Geological Settings and Samplings

The tested samples are from different geographic locations with different geological settings that influence the process of sedimentation and deposition. Due to a large number of samples, the general geological setting for each period, from the oldest period to younger period, is explained briefly along with related formations. This summarized information is provided to develop a better understanding on the samples (from a mineralogical and sedimentological perspective) that are analysed in this thesis.

2.1 Ediacaran (~630 – 541Ma)

The Ediacaran Period is a new addition to the geologic time scale, the youngest period of the Neoproterozoic era (during the evolution of hard-bodied and complex organisms). At the beginning of ~700Ma, the supercontinent known as Rodinia began decimating into three major blocks: West Gondwana, East Gondwana, and Laurasia (Clowes, 2015). Following the continental breakup with development of various subduction zones (Pan-African, Pan-Brazilian, Cadomian, and etc., this period had marked a coherent interval of Earth history with the termination of the last great global glaciation (~635 – 585Ma) where the continental glaciers reached sea level in the tropical latitudes (Hoffman and Schrag, 2002). The period ended with the beginning of a biologically distinct world characterized by diverse skeletal fossils of bilaterian animals (Knoll et al., 2006).

2.1.1 Mora Formation (Northern Spain)

Mora Formation, also known as the Narcea slates or schists group, is best studied in the eastern part of the Narcea antiform within the Cantabrian and Central Iberian Zones in Spain (Naidoo et al., 2017). A clear unconformity to Lower Cambrian rocks is visible with an alternation of slates and sandstones, muddy diamictites, and turbiditic (samples taken for this study) facies formed during the Ediacaran succession (Ugidos et al., 2016). Although it is difficult to determine the nature of sediments in the western part of the antiform, a gradual transition of concordant, igneous bodies described as porphyritic gneisses and amphibolites with volcanoclastic protolith can be recognised. However, the total thickness of this formation is unknown due to the presence of several thrusts (Dallmeyer and Garcia, 2012; Ugidos et al., 2016). The age has been determined by the presence of the acritarchs *Sphaerocongregus variabilis* and *Palaeogomphosphaeria caurensi*, indicative of late Vendian age (Ugidos et al., 2016).

2.2 Cambrian (~541 – 485Ma)

Rodinia that was broken up during the Neoproterozoic era and began to fragment into smaller continents successively in the southern hemisphere at low paleolatitudes (Kazlev, 2002a), modifying the ocean basins, forcing their expansion and flooding of parts of many continents (Robison et al., 2015). The recent Ediacaran global glaciations had caused the largest and most persistent rise in sea level reaching its maximum by the middle and late Cambrian. Continuous plate movements had formed large mountain ranges during plate collisions where significant volumes of Cambrian rocks had folded, faulted, and metamorphosed especially from the outer margins and slopes of continental shelves (Kazlev, 2002a; Robison et al., 2015).

2.2.1 Herrería Formation (Northern Spain)

The Herrería Formation is composed as the base of the Paleozoic succession, unconformably overlying Precambrian rocks. This formation comprises of sandstones with some conglomerate, shale, and dolomite intercalations. Three different members have been established i.e. (i) lower – sandstones, siltstones, shales, and dolomites; (ii) middle – feldspathic to quartzitic course-grained sandstones, little conglomerates, and some red and green shales; (iii) upper – interbedded sandstones, shales, and dolomites. From the upper member, the samples have been taken for this study. The Herrería Formation was probably deposited in a fluvio-marine transition, where the thickness gradually increases from 900m in the South to 1500m in the North of the Narcea valley (Bastida and García-López, 2002).

2.2.2 Láncara Formation (Northern Spain)

The Láncara Formation can be divided into three members: lower, middle, and an upper member. The grey dolomites with inorganic laminations and microbial laminates as well as some ooidal and stromatolitic beds is considered the lower member. There is a small portion of fenestral grey limestone found lying on top of this member. The middle member starts with glauconite-bearing grey bioclastic limestones gradually transition into condensed section of red bioclastic and nodular limestone, a griotte (upper member). Its thickness ranges from 150m to 225m (Bastida and García-López, 2002). Samples have been taken from each member.

2.2.3 Oville Formation (Northern Spain)

The Oville Formation consists of interbedded shale, siltstone, sandstone where there are frequent volcanic rock intercalations. This rock formation is mainly constituted of green shale with high fossils (trilobites) abundancy which is believed to be deposited in a shallow marine

environment. The thickness has the range of 80m to 800m (Bastida and García-López, 2002). The samples have been taken from the green shale for this study.

2.2.4 Barrios Formation (Northern Spain)

The Barrios Formation, being 80m to 1020m thick, contains white quartz arenites with minor shale and conglomerate intercalations with rounded grains. The age for this formation is estimated from Late Cambrian to Early Ordovician (Bastida and García-López, 2002). A small layer of tuff (~480Ma), approximately 45m in thickness, is within the upper Barrios Formation. Tuff is known as altered ash-fall that has deposited during a period of volcanism (Gutiérrez-Alonso et al., 2007). The depositional system for this formation is in a braided plain delta system as well as braided fluvial, alluvial sheet flood, and lacustrine deposits. (Bastida and García-López, 2002).

2.3 Silurian (~443 – 419Ma)

During this period, the continental elevations were generally much lower than present day with higher global sea level, caused by the melting of the Hirnantian ice sheets, that had flooded the extensive continental regions with the water depth from a few to little more than 100m (Johnson, 2016). The supercontinent of Gondwana stretched over the southern polar region and at least six continents were clustered around the equator. These continuous colliding of continents had formed mountains and forge a new supercontinent, Laurasia, by the end of Silurian period (Kazlev, 2002c).

2.3.1 Cancañiri Formation (Bolivia)

The Cancañiri Formation is exposed on 1500km long North-South transect from Northern Argentina over the Andes Mountain Ranges across Bolivia to Peru, with a prominent segment 60m thick of Zapla Tillite (diamictite). The thickness of this diamictite-bearing successions ranges from 100m to 1000m. Alpine glaciers advanced from high elevations down to tidewater areas which had contributed a marine environment for the deposition of these layers to occur. This is evident from the great layer thickness, abundance of re-sedimentation features and presence of marine fossils (Kazlev, 2002c; Schönian and Egenhoff, 2007).

2.3.2 San Pedro Formation (Northern Spain)

The San Pedro Formation presents with a thickness between 5m to 250m. It is easily recognised with its red fine-coarse grained ferruginous sandstone, with frequent occurrence of well-

rounded grains coated by hematite that eventually form ooidal ironstones. This Silurian siliciclastic succession was deposited in a shallow epeiric sea with frequent storm weather base environment. Since Silurian volcanism took place under subaerial condition, iron is easily weathered from basic volcanic rocks that gives a dark reddish colour to San Pedro rocks (Bastida and García-López, 2002).

2.3.3 Uncía Formation (Bolivia)

The Uncía Formation is widely spread across the Oruro District area in Bolivia, overlying conformably the Llallagua Formation. This formation is composed of dark grey shale/slates with a few parting of sandstone (Sugaki et al., 1983), and is the host rock for the Triassic and Tertiary plutons (Avila-Salinas, 1990). This formation has a total thickness of 1800m which is deposited in a shallow shelf environment (Hatløy, 2013; Sugaki et al., 1983).

2.3.4 Catavi Formation (Bolivia)

The Catavi Formation, overlying conformably the Uncía Formation, is the youngest formation in Silurian period here sampled. This 500m - 800m thick formation consists of alternating thin bedded orthoquartzites and lithic arenites along with shale and siltstones where the colour changes from grey to brown due to weathering. Interchanging sandstone and shale features exhibit internal deformation, mesoscale folds, differential thickening and thinning, and secondary detachment levels locally (Avila-Salinas, 1990; McQuarrie and DeCelles, 2001; Sugaki et al., 1983).

2.4 Devonian (~419 – 359Ma)

During this period (Figure 2), the supercontinent of Gondwana moved steadily from the southern hemisphere to North. Coincidently within the same period, two continents called Laurentia and Baltica in the North had been recently collided forming Laurasia. Extensive terrestrial deposits named “Old Red Sandstone” dominate the northern area of equatorial region while marine deposits accumulated on the southern part. When Laurasia started to drift northward, Gondwana underwent a counter-clockwise rotation around the Australian axis where these both continents were surrounded by subduction zones (House, 2014; Kazlev, 2002b).

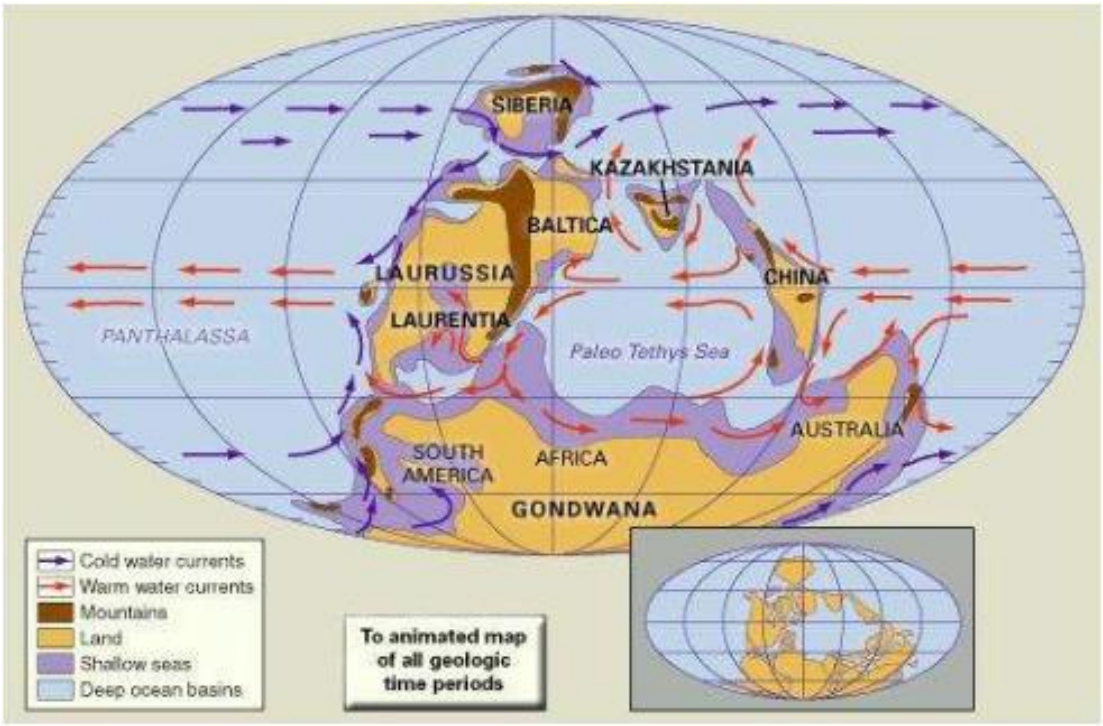


Figure 2: An illustrated world map showing the landmass distribution, mountainous regions, shallow seas, and deep ocean basins during Early Devonian (House, 2014).

2.4.1 Belén Formation (Bolivia)

The Belén Formation has a total thickness estimated to be 1800m. Its lithology consists of silty mudstone with intercalated fine grained sandstone and coarse grained quartz arenite beds. Small, fossiliferous, and slightly calcareous nodules are spread throughout the formation in various concentrations. It is considered to have been deposited in a cold, very shallow marine environment. Environment of deposition range from shallow intertidal in the lower formation to subtidal in the upper part of Belén (Isaacson and Sablock, 1988).

2.4.2 Sica-Sica Formation (Bolivia)

The Sica-Sica Formation is well exposed throughout North-Western Bolivia which divided into three members with different lithology content. In the lower section, it consists of micaceous, fine and medium well cemented grained sandstone that grades upward to micaceous siltstone, largely unfossiliferous. Micaceous and medium grained quartz arenite with sub-angular grains can be found in upper formation, and its reddish colour indicates a high content of hematite. The thickness of the formation ranges between 570m to 670m (Isaacson and Sablock, 1988).

2.4.3 Pedrosa Formation (Northern Spain) – La Vid Group

The Pedrosa Formation has a thickness of 107m at the type locality, composed of bioclastic limestones, silty limestones, nodular to wavy bedded wackestones to mudstones, shales, and

marlstones. The sequence of sedimentation coincided with storm-generated sediments deposit from an inner- to mid-ramp environments to the outer- or deep-ramp environment. The deepening progression is noticeable by condensed sequences and hard-ground development (Bastida and García-López, 2002).

2.4.4 Coladilla Formation (Northern Spain) – La Vid Group

The Coladilla Formation has a thickness of 35m, is easily recognised with its deposition of red marls with shales and bioclastic carbonate lenses. Red fossiliferous crinoidal limestones intercalated among shales are layered after, where the limestones exhibit cross-bedding and small biostromes (Bastida and García-López, 2002).

2.4.5 Santa Lucía Formation (Northern Spain)

The Santa Lucía Formation is a 250m thick shallow marine carbonate deposit. Grainstones are deposited in both lower and upper part (with varying interbedded marly packstones) of the formation, presenting relatively high energy turbulent conditions originated by currents in an open marine environment during deposition. The middle section has boundstone facies and reef development corresponds to quiet subtidal area. Overall, this unit suggests a subtidal and very fossiliferous facies southwards and shallower and peri-tidal deposits northwards (Bastida and García-López, 2002).

2.4.6 Huergas Formation (Northern Spain)

The Huergas Formation is a siliciclastic sedimentary deposit that includes consolidated sandstones and sandy limestones deposited mainly in the lower and upper part of the formation with 400m of euxinic, nodular dark shales found in between. With a sharp lithological change in the boundary between the Santa Lucía and Huergas Formations, a deepening episode in the basin is supported. The formation's thickness can varies from 25m to 200m depending on the level of deformation (Bastida and García-López, 2002).

2.4.7 Portilla Formation (Northern Spain)

Being approximately 60m thick, the Portilla Formation is composed of argillaceous and crinoidal limestones, marls, and shales. This formation is a complex of biostromal facies (had been divided into several units) which is proposed to be deposited either on a reef-rimmed carbonate platform or proximal facies northwards and distal facies southwards due to the non-existence of reef barrier (Bastida and García-López, 2002).

2.4.8 Colpacucho Formation (Bolivia)

The Colpacucho Formation is lithologically equivalent to the Iquiri Formation in the Subandean Belt as mentioned by Isaacson et al. (1995) and consists of sandy units predominantly intercalated with shaly units. The sandy units are comprised of medium to fine-grained sandstones, micaceous and siliceous sandstones (Kuhn, 1991). The thickness of this formation is estimated to range between 500m to 900m (McQuarrie and DeCelles, 2001).

2.4.9 Cumaná Formation (Bolivia)

A diamictite unit and associated lithofacies, the Cumaná Formation, is located above the Colpacucho Formation with variable thickness reaching up to 130m, 80km along strike from Isla del Sol. Variable compositions of formation together with the presence of striated and faceted clasts suggested a glaciated heterogeneous depositional environment. Sub-angular to well-rounded clasts within diamictite has the size ranging from coarse sand to boulder size fragments (Diaz-Martinez and Isaacson, 1994).

2.5 Carboniferous (~359 – 299Ma)

During Early Carboniferous, a series of cratonic blocks (Laurasia, Kazakhstan, northern and southern China, etc.) was situated in the northern hemisphere, near the paleoequator and the supercontinent Gondwana was located at the southern hemisphere. Plate movements had brought Laurasia in contact with Gondwana by the Early Carboniferous and collided fully during the Late Carboniferous to form the Appalachian-Hercynian orogenic belt. The continental interiors were terrestrial, underwent substantial erosion; fringe area of these continents were submerged in shallow seas (Manger, 2017).

2.5.1 San Emiliano Formation (Northern Spain)

Alternating sandstones, shales, sandy shales, limestones, and a high abundance of coal seams are found in the San Emiliano Formation where three members are divided based on these different proportions of lithology. This 1800m formation is distinguished into three major depositional phases: basin initiation and basinal sedimentation in the lower section, an alternating marine carbonate and deltaic clastic phase for the middle section, and a clastic dominated deltaic phase at the upper part of the succession (Bastida and García-López, 2002).

2.5.2 Guandacol Formation (Argentina)

Since the Guandacol Formation has thirteen massive lithofacies, that have been grouped into three facies associations. First facies is composed of coarse-grained massive and stratified diamictite, laminated siltstones with dropstone, and interstratified sandstone and mudstone, represent both tillite and resedimented diamictite to small water bodies. Facies Association II had been through the process of subaqueous cohesion-less debris flows, coeval rainout of ice-rafted debris, and fine-grained particles settling from suspension. These processes had resulted couplets of matrix-supported thinly bedded diamictite and laminated mudstone with dropstone. The last and third facies association is in a deep marine environment where laminated mudstone without dropstone, thick marl levels, and scarce fine to very fine-grained sandstone are deposited (Marenssi et al., 2005).

2.5.3 Copacabana Formation (Bolivia)

The Copacabana Formation, from Late Carboniferous until Mid-Permian, has a thickness ranging from 142m to 296m with compositions of various rock types. These rock types include limestone, dolomite, chert, anhydrite, mudstone, green siltstone, and a layer of volcanogenic matter (Isaacson et al., 1995). Progradational autocyclic controls from multiple shorelines or high-frequency shingled cycles typical of icehouse ramps have resulted the stacking pattern of this complex facies (Grader et al., 2002).

2.6 Permian (~299 – 252Ma)

Northwestern Gondwana collided and merged with southern Laurasia during the Early Permian, continued with its amalgamation to the Angara craton. Soon after the collision, the assembly of Pangea was complete. Glaciation was still widespread during the Early Permian where latitudinal climatic belts were strongly developed, hot and dry conditions were extensive rather during the Late Permian. Sea level rise and fall is obviously displayed in Permian strata associated with these climate changes (Ross and Ross, 2018).

2.6.1 Chutani Formation (Bolivia)

The Chutani Formation has a mix lithology of silty dolomite interbedded with mudstone, marl, and fine-grained sandstone. Semi-arid tidal flat with mixed carbonate and siliciclastic deposition is suggested as to be the deposition environment. (Vieira et al., 2004).

2.7 Triassic (~252 – 201Ma)

Supercontinent of Pangea was relatively quiescent during this period with warm and dry terrestrial climates even though seasonal monsoons occurred over the oceans. Islands, seamounts, and volcanic archipelagoes were scattered around the equator. However, plate tectonic activities were picking up and continental rifting began at the Late Triassic. Increase of tectonic activities had contributed to rising sea levels and increasing shallow continental shelf seas (Logan, 2017).

2.7.1 Tiquina Formation (Bolivia)

The Tiquina Formation consists of intercalations of red sandstone and mudstone with conglomeratic sandstone and basalt-clasts conglomerate locally. Fine to coarse grained rock units with approximately 500m thick are generally deposited in restricted area like paleo-grabens whereas the overlying fluvio-eolian sandstones are present in much broader regions. Presence of tuff and fine-grained volcaniclastic sandstones (reworked pyroclastic deposits) with basaltic lavas has proved there is a volcanic source (Sempere et al., 2002).

2.8 Jurassic (~201 – 145Ma)

Significant global change in continental configurations, oceanographic patterns, and biological systems occurred in this period. Large plate tectonic movements took place when Pangea split apart along with volcanic activities, mountain-building events, and attachment of islands onto continents were highly active. The steady opening of continents had caused accumulation of thick flood basalts and a subsequent deposition of sediments in the ocean basins. Numerous microplates and blocks contributed to the complex Caribbean region were constructed during this period (Tang, 2017).

2.8.1 Gijón Formation (Northern Spain)

The first formation (sampled) for the Early Jurassic in Spain is the 100m to 150m Gijón Formation that comprises an evaporitic, dolomitic, carbonate complex. The facies associations tend to be a sabkha to hypersaline coastal lagoon, gradually derived towards barrier-lagoon and microtidal flat system. Rare presence of ammonites in the formation indicates the influence of marine environment (Aurell et al., 2002).

2.8.2 Rodiles Formation (Northern Spain)

A marine, rhythmically bedded marl with limestone of Rodiles Formation is deposited on a carbonate ramp at various water depths, from above fairweather wave base to below storm wave base. The total formation thickness of approximately 160m had been defined into two members with the lower member comprising of alternating marl and limestone interbeds with tempestitic structures and well-bedded marls and limestones ordered in shallowing-upward cycles in the upper member. Black shale episodes are also recorded (Aurell et al., 2002).

2.8.3 Vega Formation (Northern Spain)

The Vega Formation has a complex depositions of interbedded siliceous conglomerate, sandstone, and mudstone up to 160m thick. The formation stratigraphy has formed a series of meter-scale fining-upward cycles with carbonate lacustrine intervals. An alluvial plain crossed by ephemeral, high sinuosity rivers is the deposition environment for this unit under semi-arid climatic conditions (Aurell et al., 2002).

2.9 Cretaceous (~145 – 66Ma)

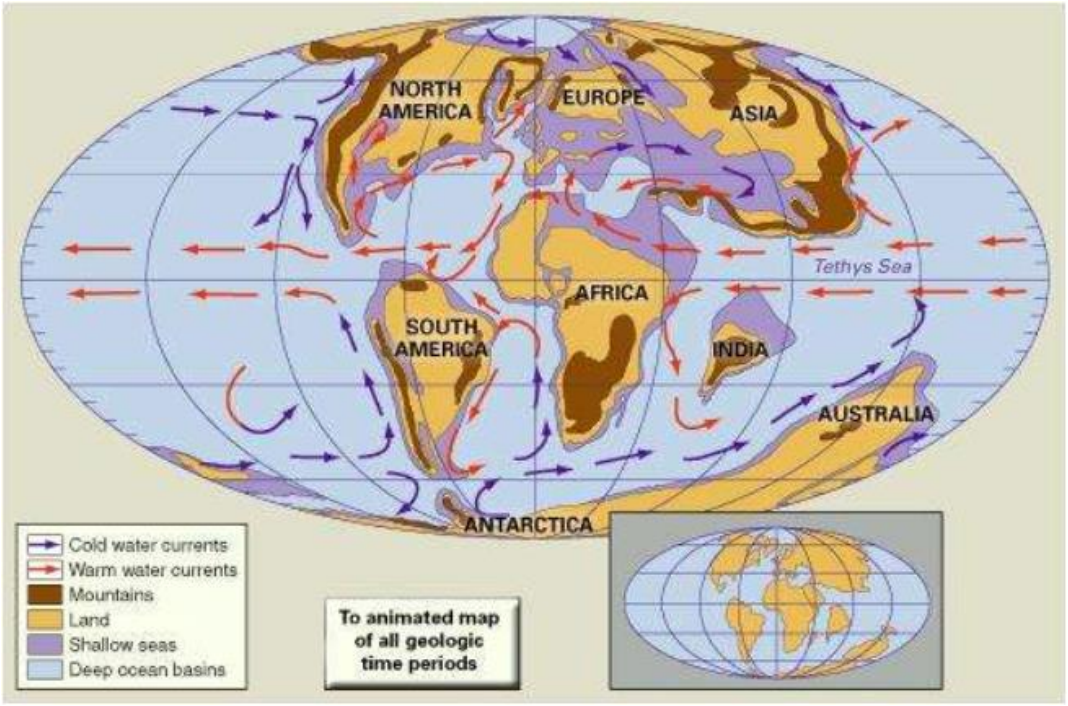


Figure 3: The world map during Late Cretaceous that had similar continents with present days but in different positions (Hansen and Koch, 2018).

At the beginning of Cretaceous, the Earth was assembled into two continents, Laurasia in the North and Gondwana in the South where various segments started to rift apart. The climate was warmer and more humid probably due to active volcanism and high rates of seafloor

spreading. Sea level during Cretaceous is considered the highest among all the periods resulting from enlargement of mid-oceanic ridges causing seawater being displaced. When comparing to present day, the sea level was 100m to 200m higher in the early period and 200m to 250m in the end of period (Figure 3) (Hansen and Koch, 2018).

2.9.1 Mattinata Formation (Italy)

The Mattinata Formation represents the succession of carbonate which is rich in gravity-displaced calciturbidites and breccias, interbedded with cherty micritic limestone. The formation is divided into lower and upper sections by a wedge of pelagic limestone with thin beds of black shale. Inner-platform facies and slope-to-basin sediments are the possible deposition environments with high-stand systems tract of sequence supported by the existence of graded breccias and calciturbidites (Bosellini et al., 1999).

2.9.2 Ulster White Limestone Formation (Northern Ireland)

Stage	Zone	Member	Lithology
		Unconformity	
Early Maastrichtian	*Belemnella occidentalis*	Ballycastle Chalk (13.72m)	White limestone in 7 beds; dissolution weathering of flints in upper three beds
	Belemnella lanceolata	Port Calliagh Chalk (12.40m)	White limestone in 6 beds; flint-rich; occasional green-coated chalk pebbles
		Tanderagee Chalk (7.36m)	White limestone in 5 beds; base marked by the Long Gilbert Flint Band
Campanian	*Belemnitella mucronata*	Ballymagarry Chalk (10.95m)	White limestone in 3 beds; largest flints (paramoudra) in Irish chalk, continuous flint bands
		Portrush Chalk (14.28m)	White limestone in 4 beds; abundant *Inoceramus* debris; South Antrim Hardgrounds
		Garron Chalk (9.65m)	White limestone in 3 beds; giant flints often in circles; wavy-bedded at top
		Glenarm Chalk (8.0m)	White limestone in 4 beds; small and large flints; North Antrim Hardgrounds
		Ballintoy Chalk (12.65m)	White limestone in 2 beds; at top is the Altachuile Breccia
		Larry Bane Chalk (7.29m)	White limestone in 2 beds; demarcated by three marked erosion surfaces
	Gonioteuthis quadrata (pars)	Boheeshane Chalk (24.19m)	White limestone in 3 beds; very fine-grained chalk lacking *Inoceramus* fragments; small to massive flint bands; Whitehead Flint Band
	Offaster pilula (pars)	Creggan Chalk (3.45m)	White limestone in 1 bed; abundant *Inoceramus* fragments; stromatolite biostrome; Bendoo Pebble Bed at top
Santonian (pars)	*Marsupites testudinarius*	Cloghastucan Chalk (2.23m)	White limestone in 1 bed; small scattered flint nodules are burrow fills; Oweynamuck Flint Band just below top
	Uintacrinus socialis (pars)	Galboly Chalk (5.85m)	White limestone in 1 bed; abundant *Inoceramus* fragments; wavy bedding; white and black flints
		Cloghfin Sponge Beds (1.47m)	Glauconitic limestone in 3 beds; flint-free; cobbly base and wavy-bedded top
		Unconformity	

Figure 4: A stratigraphic column that shows fourteen members in Ulster White Limestone Formation from different stage with detailed lithology descriptions for each member (Mitchell, 2004).

Fourteen members of chalk units (Figure 4) with extremely hard texture comparing to other chalk formations are identified in the Ulster White Limestone Formation, a coccolith-foraminiferal micrite with flints. This is caused by secondary calcite cementation in pore spaces with the calcite developed from pressure solution during compaction where chalk with higher density and lower porosity was being formed. This formation has a total thickness of approximately 133m where the deposition was strongly influenced by contemporaneous tectonism, the control of basement structure and extent of depositional basins (Mitchell, 2004).

2.9.3 Mons Basin (Belgium) - Nouvelles, Saint Vaast, Spiennes and Trivières Formations

The Nouvelles, Saint Vaast, Spiennes and Trivières Formations are chalk depositions which are the part of the Mons Basin that deposited in Campanian and Maastrichtian Stage. The detrital supply that was previously present vanished and the chalk sea was installed. Chalk that are deposited have either very fine carbonate particles such as intraclasts or coarser carbonates with little rounded granules of phosphate white, yellow to brown grains. Some of the Maastrichtian chalk units are identified to be rich in phosphate debris (Boulvain and Vandenberghe, 2018).

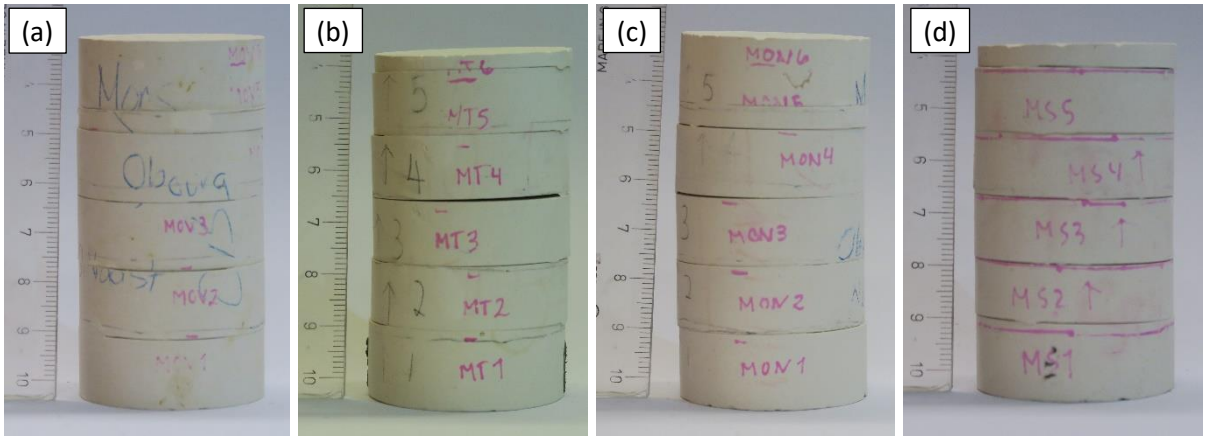


Figure 5: Chalk core samples that are used in the study from Mons Basin.

Sample MT1-MT5 (Figure 5b): These samples are from the second chalk formation (Trivières) in Mons Basin after Saint Vaast Formation (MOV1-MOV5; Figure 5a), followed by Nouvelles Formation (MON1-MON5; Figure 5c) and Spiennes Formation (MS1-MS5; Figure 5d). All of these samples have high similarity in texture and colour which is a white fine-grained carbonate. Coccolithophores and fragments of foraminifera shells are dominating these chalk formations.

2.9.4 Gulpen Formation (Belgium)

The Gulpen Formation is an approximately 60m thick bed with superimposed rhythmic variation grain size and laterally continuous flint nodule layers, divided into five members (Zeven Wegen, Beutenaken, Vijlen, Lixhe, and Lanaye). The succession consists of bioturbated muddy to silty subtropical shallow-marine bioclastic carbonates homogeneously. The lower part of the formation is smectitic followed by planar-parallel and laterally continuous silica concretion layer in the upper part (Zijlstra, 2006).

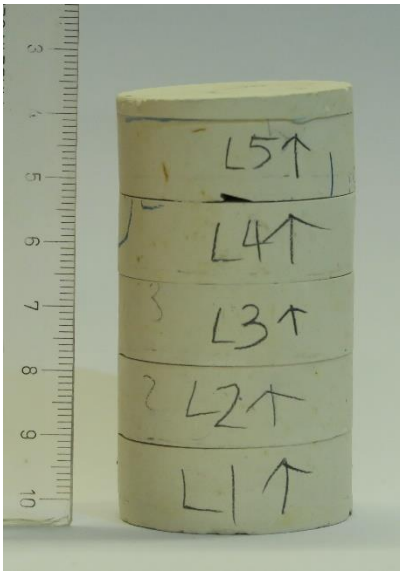


Figure 6: Liège core sample

Sample L1-L5 (Figure 6): Liège samples are white in colour with slightly grey fine grained chalk found in the Gulpen Formation as Zeven Wegen Member. Accumulated glauconite is present in the the basal zone of this member with randomly distributed black, fine-grained flint but is not found in the tested core sample.

Another Liège chalk core sample from the same formation was flooded in simple brine solution of $MgCl_2$. The core was sectioned into seven slices and named S1-S7, from inlet to outlet (Andersen et al., 2017). Sample S1 and S7 are used in this SSA analysis.

2.9.5 Hod Formation (North Sea)

The Hod Formation lithology consists of white, light grey to light brown chalk alternating with limestones that appear pink or pale orange in colour. Thin, silty, soft, and grey to black calcareous shale laminae is occasionally present throughout the formation. Occurrences of pyrite and glauconite can also be spotted in this approximately 500m thick formation which formed in an open marine environment along with deposition of cyclic pelagic carbonates and distal turbidites (Norwegian Petroleum Directorate, 2013a).

2.9.6 Tor Formation (Denmark, North Sea)

The Tor Formation has a thickness ranging between 474m to 600m. The formation is generally homogenous, consisting alternating white to light grey or beige, rarely soft, mudstone or wackestone, and chalky limestone. Fine layers of soft grey to green marl and calcareous shale can be found in the formation occasionally. The formation's depositional environment is open

marine with deposition of calcareous debris flows, turbidites, and autochthonous periodites (Norwegian Petroleum Directorate, 2013b).

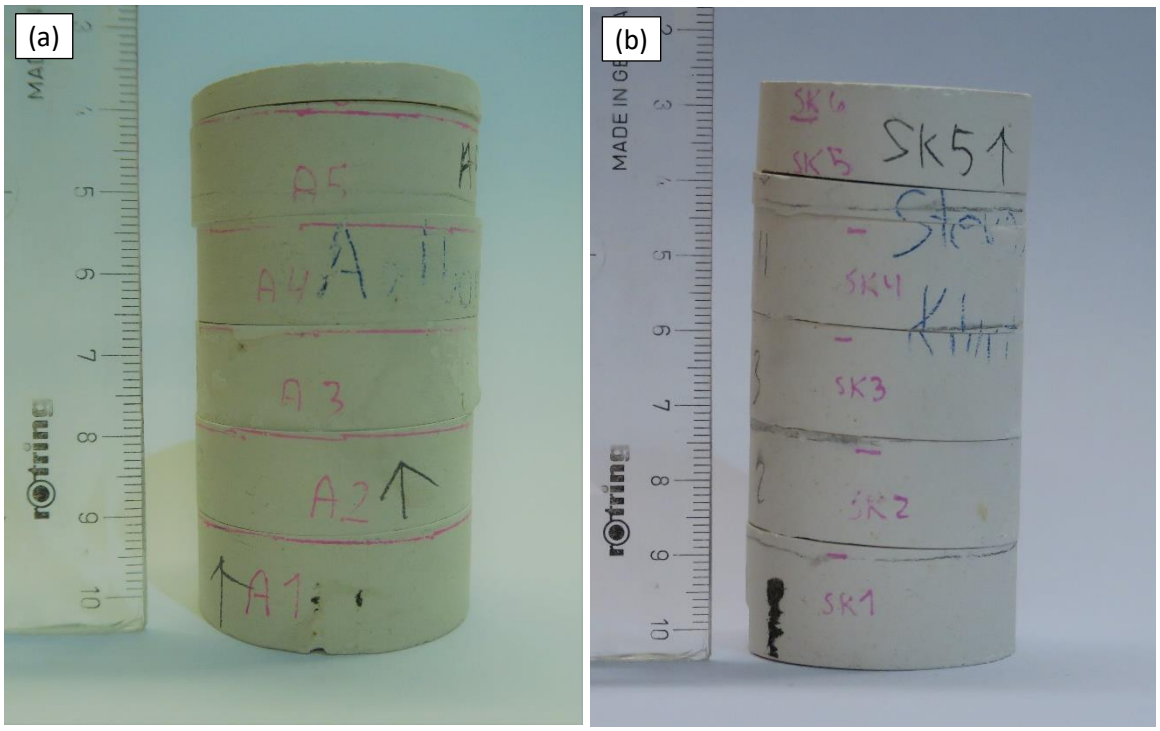


Figure 7: (a) Aalborg chalk core sample (b) Stevns Klint chalk core sample

Sample A1-A5 (Figure 7a): These Aalborg samples are predominantly chalk lithology belonging to the Tor Formation. The samples are white in colour along with typical microfossil communities and layers of abundant benthic fauna. The samples present a fine texture and lacked any notable micro-structures.

Sample SK1-SK5 (Figure 7b): Stevns Klint samples are collected from Sigerslev Member of Tor Formation, deposited in less deep water compare to Aalborg chalk from the same formation. This white chalk is characterised by abundant microfossils and bryozoans without any structures or re-sedimentation. There is a small distribution of chert nodules.

2.9.7 Niobrara Formation (USA)

Eight lithologic units were mapped in the Niobrara Formation with a total thickness of approximately 240m. In ascending order, the units start from thick beds of limestone with almost no shale, shale and limestone, lower shale, lower limestone, middle shale, middle chalk, upper chalky shale, and lastly upper chalk. The environment during deposition tended being warm, marinal, along with several sea-level fluctuations that created the alternating layers of different rock units (Scott and Cobban, 1964).

Figure 8: Kansas chalk core sample

Sample K1-K5 (Figure 8): Kansas samples are clayey chalk of bentonite in Niobrara Formation where greyish spots are seen on the pale yellowish core. After grinding, the chalk powder is presented in white colour. It is a very fine grained carbonate rock with a large composition of micrite and microspar, foraminifera, and calcareous nanoplankton remains.

Sample S3 (middle) and S7 (outlet) from flooded Kansas chalk (same study as flooded Liège chalk sample) are chosen for further SSA analysis.

2.10 Tertiary (~66 – 2.6Ma)

With continuous tectonic activities and rearrangement of Earth's plates, continents with similar geography as present day slowly set in place. The progressive separation of two continents in two hemispheres had led to the development of the Antarctic Circumpolar current which thermally isolates Antarctica from the effects of warmer waters and climates to the North. Then later the collision of India and Southern Asia plate had blocked the westward-flowing Tethys seaway and creation of Himalayas and the Plateau of Tibet. By the Late Tertiary Period, a polar ice cap had developed in the northern hemisphere due to newly invigorated current (North Equatorial Current) that had carried warm, salty waters into high northern latitudes, increasing evaporation rates and great precipitation (Allmon, 2017).

2.10.1 Aranjuéz Formation (Bolivia)

The Aranjuéz Formation consists of massive, dis-organized conglomerate interbedded with pebbly sandstone, and sandy mudstone with combined thickness measured to be approximately 340m. The conglomerate beds are matrix-supported while mudstone and sandstone beds are massive to thinly bedded comprising of fine grained sand to pebble-rich lenses. Reworked ash-fall tuffs are found in some parts of the sandstone and mudstone sections. The depositional environment is in the medial to proximal zone of an alluvial fan with high energy sediment and fluid gravity flows (Murray et al., 2010).

Chapter 3: Methodology

Various type of rock samples are used in SSA analysis in order to ascertain the influence of different sediments towards the measurement. Chalk is the dominant rock type used in the analysis that was sourced from several formations in different locations that have distinctive grain sorting and grain sizes. Apart from chalk, other rock types were included but are not limited to sandstone, limestone, shale, tuff, etc. to add some diversity to the SSA analysis. All the sample preparation was done in the laboratory since the process of sample collection was done during students' field trips of previous years.

3.1 Sample Preparation

3.1.1 Chalk

Once chalk and other rock samples from different locations and formations are chosen, the samples need to be prepared for several measurements and analyses. The SSA analysis requires samples to be in powder and pellet form or small rock fragments.

Large blocks of chalk samples (Figure 9a) were retrieved from their original areas with the intention of running different types of studies at University of Stavanger (UiS). SSA measurement and analysis is one of the studies that had been proposed to characterize this reservoir rock, of highest importance for Norway further. Chalk samples were prepared in cylindrical cores (Figure 9b) which were cored at UiS.

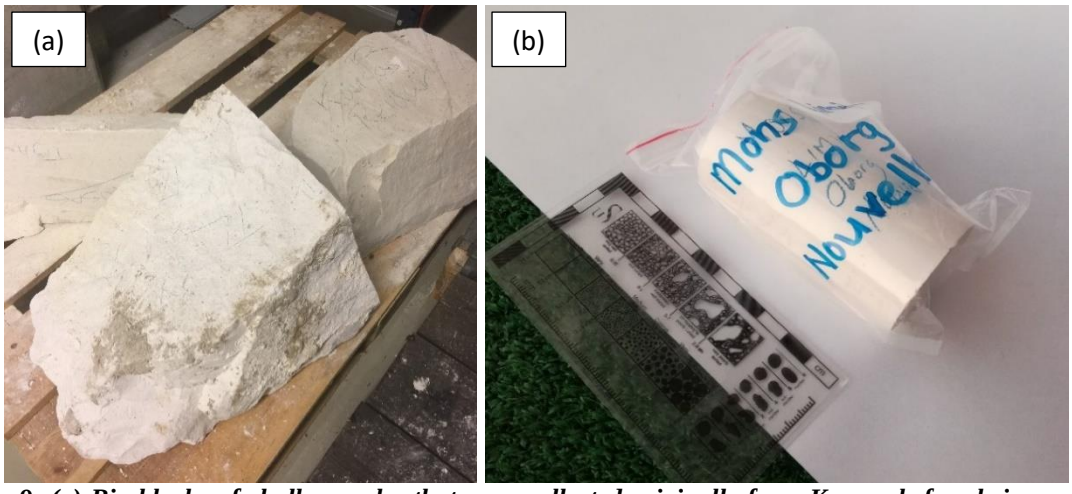


Figure 9: (a) Big blocks of chalk samples that were collected originally from Kansas before being cored in University of Stavanger. (b) An example of prepared cylindrical core samples; Mons, limit Obourg Nouvelles; the sample has a length of approximately 8.5cm.

The cylindrical cores which range in size approximately 8cm to 10cm were cut into six sections using Struers Accutom-50 with a circular blade without water in low speed (Figure 10a). This

is to avoid chalk samples to be soaked with excessive water that will defect the origin of the samples and low speed cutting will prevent soft-textured chalk to crumble. The top section of the core is cut into smaller slab with the weight around 5 grams to be sent for geochemical analysis. The bottom section is the oldest part of the core which gradually grades into younger chalk towards the top section. The sections are numbered from 1 to 5 i.e. oldest to youngest respectively (Figure 10b; Figure 11). Each section is then cut into quarters where one of the quarters is used for fossils thesis studies and stored in individual containers (Figure 12a).

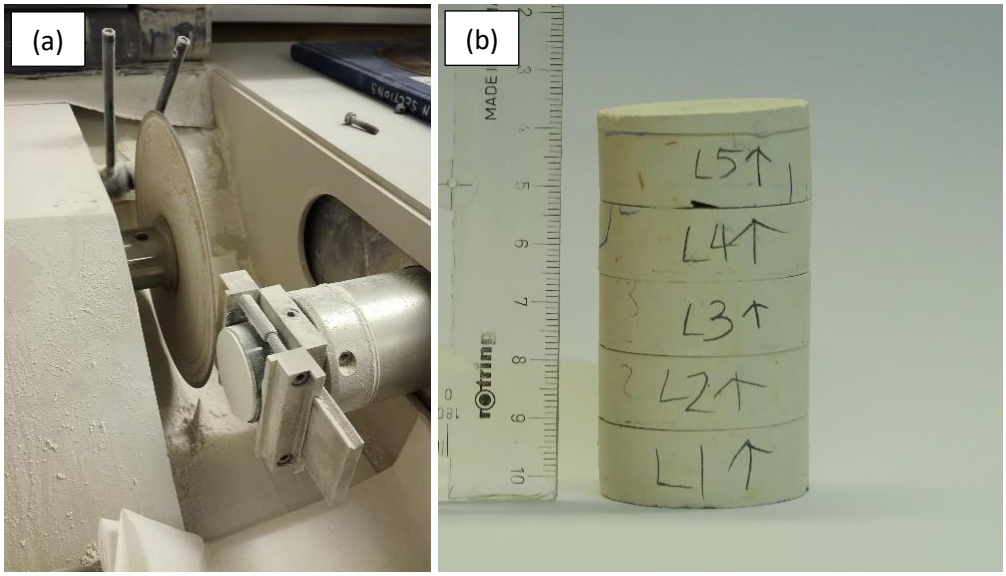


Figure 10: (a) Core sample being dissected using Struers Accutom-50 with a low velocity circular blade. The powdered sample during sample cutting is collected from the equipment due to its soft texture. (b) Core sample sectioned and labelled accordingly.

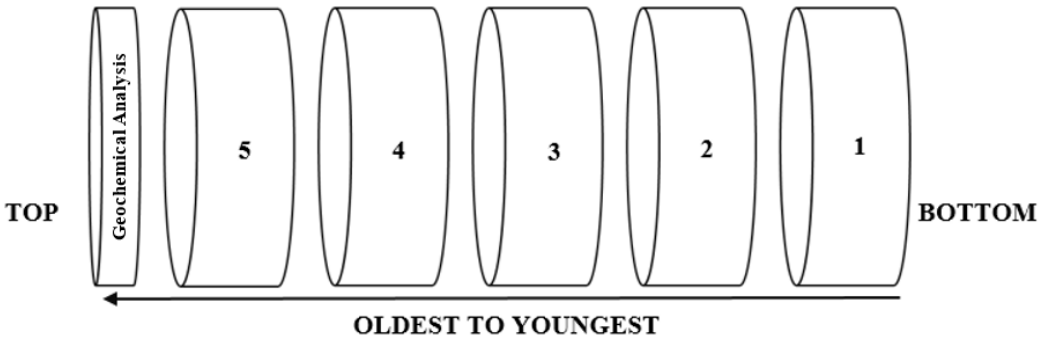


Figure 11: Schematic diagram showing how chalk sample is cut into six sections where the top section has the youngest age is used for geochemical analysis.

The samples are snipped using pliers into pellets with the size of 5mm x 5mm x 5mm in order for them to fit through the sample tubes (Figure 12b). The samples are also being ground into powder using hand in a mortar easily for estimated 20 minutes as chalk has a soft texture (Figure 12c). A machine grinder is not used as the process will destroy the structure of the minerals. The samples are checked to ensure they are all in fine grained. The mortar is cleaned with water and blow dried after each grinding to avoid contamination of samples and unwanted

particles. At least 2 grams of each of these samples are collected to ensure adequate substance is available for accurate SSA measurement. Due to the limited availability of samples such as flooded chalks and those from North Sea, these samples are prepared for as minimum as 1 gram in powder form even though it may influence the measurement results.

Figure 12: (a) Sections of chalk samples are quartered where each quarter is used for palaeontology study and stored into transparent containers. (b) Samples snipped into pellet form and ready to be used in SSA measurement and analysis. (c) Samples being powdered using mortar to avoid the destruction of minerals.

3.1.2 Other Samples

3.1.2.1 Samples from South America

Sandstones and siltstones are collected from Bolivia and are brought back to University of Stavanger to run a several laboratory studies such as porosity and permeability including SSA analysis. These sandstone samples need to be prepared into small rock fragments.

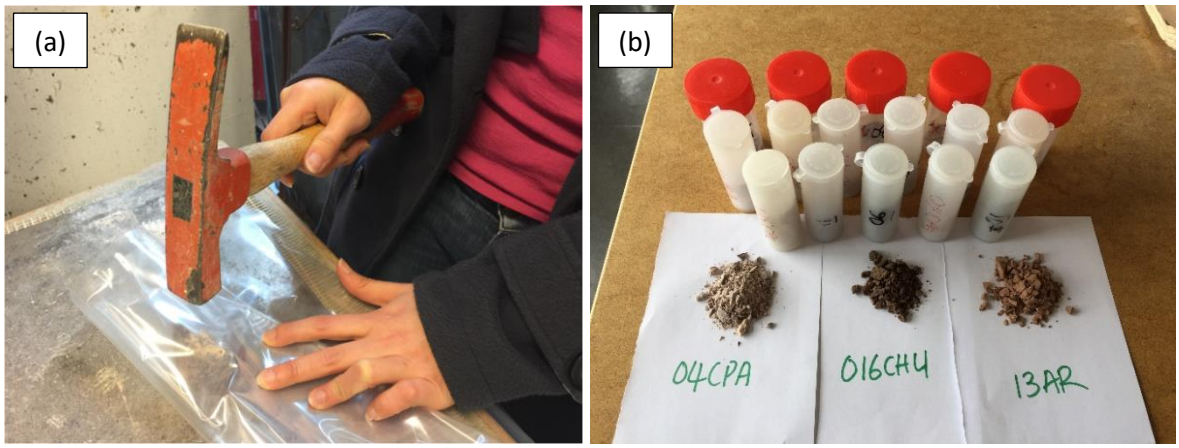


Figure 13: (a) Sample is put into multiple sets of thick layered sampling bags to avoid easy rupture while hammering. (b) Rock fragments of samples from Bolivia. The sizes of these rock sample fragments are irregular with different texture and colour.

Uncrushed rocks are put into clean sampling bags and pounded by geological hammer (Figure 13a). To ensure the cleanliness of the samples, all surfaces need to be wiped clean including metal surface and geological hammer. As sandstone is crushed roughly by hammer, it was hard to ensure the rock fragments to be in desired size. This led to a larger amount of crushed

samples that provided better choices in choosing the fragments to be tested (Figure 13b). Similar preparations are made for other South American samples that were available in the university's rock collection. An important point to be made is that in certain cases there was a slight deviation from sample preparation guidelines as certain samples have fragile textures that are too soft to be hammered and deteriorate the shape with just a little pressure applied. In such circumstances these soft samples were tested with a raw mixture of crumbled grains and minute fragments. A majority of such samples were sourced from South America and thus were not ground to be tested in powder form. A quick reference to the various samples types used during the analysis is provided via Table 5 and Table 7.

3.1.2.2 Samples from Spain

In 2013, students from the Bachelor programme had a field excursion in Spain for their bachelor thesis. They collected fresh samples from different formations and brought them back to UiS for several engineering analyses. Since there were two groups of students focused on similar research, SSA measurements and analyses were run again towards these samples to compare the results for accuracy. All these samples (Nineteen samples with different rock types including sandstone, shale and etc.) were already prepared in powder form and packed properly in sealed sample bags (Figure 14).

Figure 14: Nineteen samples from previous Bachelor student's excursion in Spain during 2013 were milled and packed properly in labelled sealable sampling bags.

3.2 SSA Measurement and Analysis

The specific surface of a porous material is defined as the interstitial surface area of the voids and pores either per unit mass or per unit bulk volume of the porous material (Dullien, 1992). The processing and behaviour of powders and porous solids is influenced by rates of dissolution and other rate-related phenomena such as moisture retention that is correlated with the specific surface area. The common method of estimating specific surface area is by using the volumetric method via gas adsorption analysis where it corresponds to the roughness of the particle exterior and porous particles interior (Quantachrome Instrument, 2017).

The samples that were prepared previously is moved to another laboratory where specific surface area experiments are performed. During all of the procedures, rubber gloves are worn at all times to ensure the cleanliness and purity of the equipment and materials. There are six bulb-shaped glass sampling tubes that are numbered in sequence. These empty sampling tubes are dried in the oven (Figure 15a) and later brought to room temperature before weight measurements together with paired rubber studs to avoid various environmental influences on their weight. Pellet samples are filled into the sampling tubes using forceps; powdered samples are poured through a Teflon sample tube cap (Figure 15b). Individual samples are placed in each glass tube and a record is made to keep track of them (Figure 17a). The samples are filled into the sampling tubes to approximately half level of the "bulb" such that the sample mass is approximately 2 grams (more mass for samples that have higher density) to reach the highest accuracy for BET analysis. During all the weighing processes, the sampling tubes are balanced on the centre of the weighing machine using styrofoam donut as a holder apparatus since accurate mass measurements are very essential for proper BET calculation.

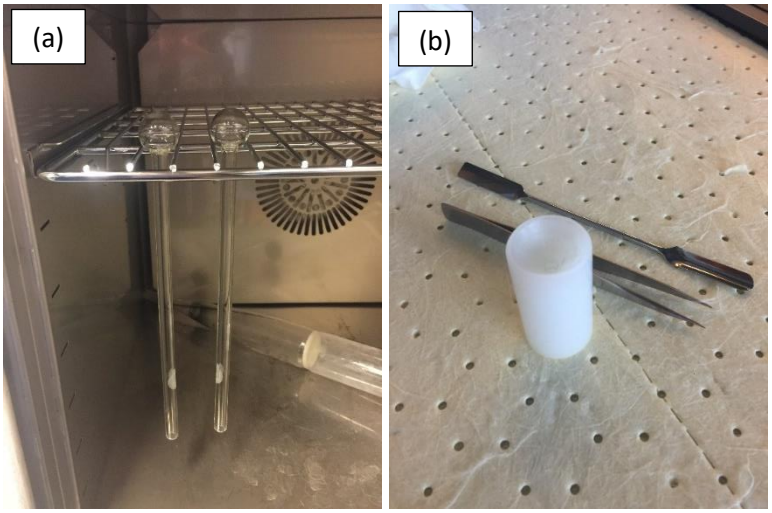


Figure 15: (a) Bulb-shaped glass sampling tubes are thoroughly cleaned with acetone and water and are set to be dried in oven. (b) Simple utensils that are used: spatula, forceps, and Teflon sample tube cap.

Prior to analysis, the sample must be preconditioned to remove physically bonded impurities and excessive moisture from the surface of pellet and powder in a process called degassing. These sample-filled glass sample tubes are degassed using a "Micromeritics VacPrep 061" degasser (Figure 16a) by applying elevated temperature for three hours in conjunction with vacuum conditions depending on the samples' texture and composition. The temperature that is used for degassing needs to be chosen carefully to avoid any physical or chemical changes that could affect the sample's surface characteristics; 80°C is chosen for chalk degassing process whereas other rock types are degassed at 150°C. Referring to previous Bachelor's student thesis reports, the samples from Spain were degassed for at least six hours without mentioning the consistent temperature. In order for Spain's samples to be tested under consistent environment, six hours of 150°C is used for degassing process. Upon releasing the sampling tube from the holder after three hours (or six hours) of degassing, the tube's opening needs to be closed immediately to minimize the sample being exposed to environment influences that made effect the BET calculation result. Once cooled for 5-10 minutes, the sample mass after degassing is measured again by subtracting the mass of empty sampling tube as this is the truest value that would be used for the SSA analysis (Figure 16b).

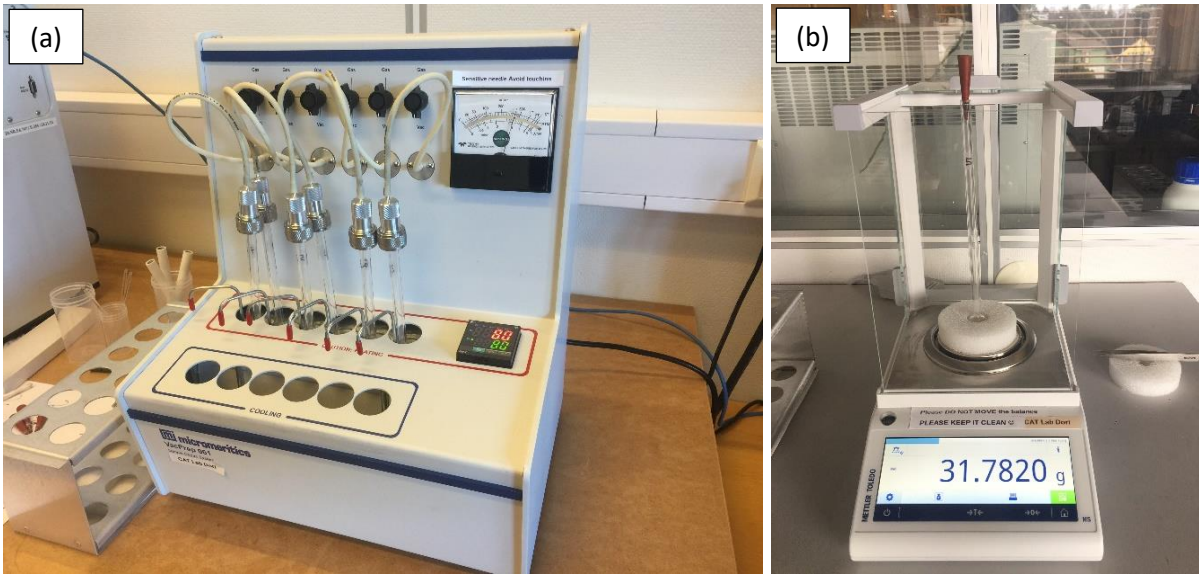


Figure 16: (a) Degasser Micromeritics VacPrep 061 can degas six samples at the same time in vacuum condition. (b) Sample filled tube is weighed with rubber stud on to avoid environmental exposure after degassing; due to the sensitivity of the weighing machine, measurements are taken accurately and cautiously.

The sampling tubes are then attached to the three ports of the BET measuring machine (Micromeritics TriStar II). The sampling tube is inserted with a filler tube to fill up excess void space and preventing adsorption of physisorption gas to internal glass surface. The tube is protected with polyester styrofoam before the connector nut, a metal ferrule and an O-ring are added and then screwed tightly into port to avoid leakage (Borch, 2016). The cryotrap dewar

is filled with liquid nitrogen until the maximum level indicator mark of a polymer dipstick (Figure 17b) and is put on the platform underneath the samples. Information such as sample name and mass are recorded into the software connected to instrument and SSA measurement analysis is started once all of these are ready (Figure 17c). The SSA analysis takes a few hours depending on rock types and pore volumes.

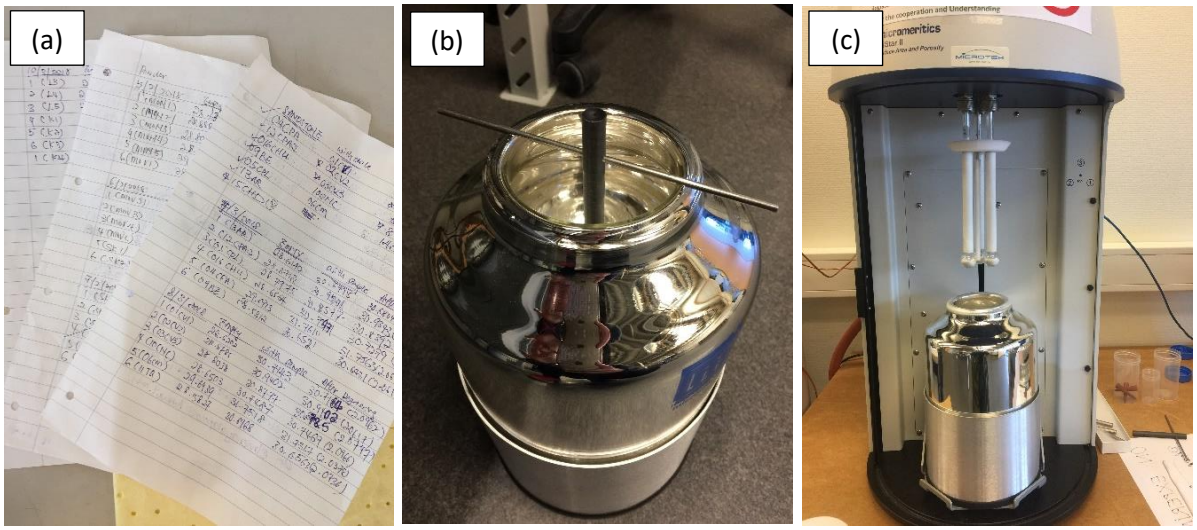


Figure 17: (a) All the measurements are kept in paper record. (b) Liquid nitrogen is filled into the cryotrap dewar while using the polymer dipstick to indicate liquid level. (c) Three sampling tubes are slotted into the Micromeritics TriStar II ports with filled cryotrap dewar placed underneath, and thus ready to be analysed for specific surface area.

The volumetric method is commonly used in measuring gas adsorption where a small quantity of adsorbate gas such as nitrogen is admitted into the evacuated sample chamber that will give a defined equilibrium pressure of the gas (Loebenstein and Deitz, 1951). Because only pure adsorbate gas is employed, interfering effects of thermal diffusion are avoided in this method. The BET theory is applied in this method to evaluate the gas adsorption data and generate a specific surface area result expressed in units of area per mass of sample.

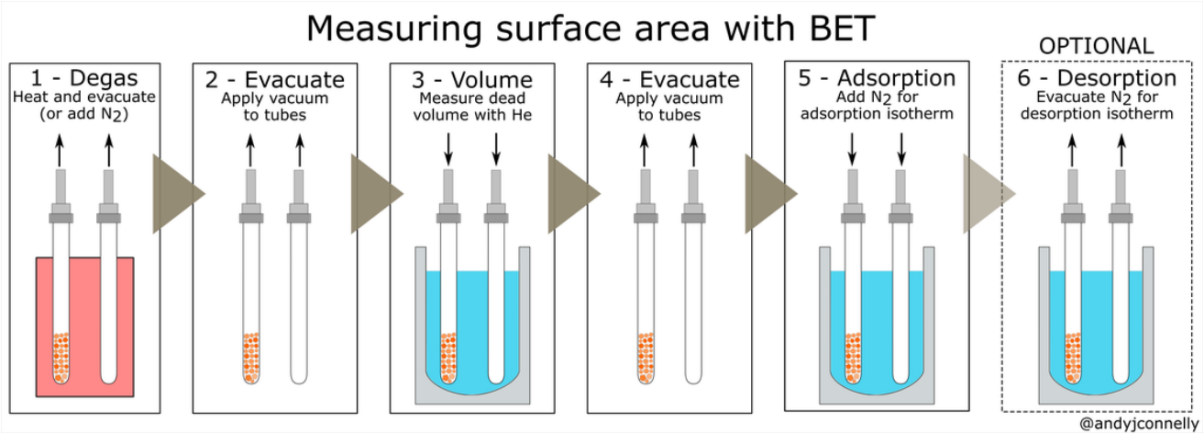


Figure 18: The whole process of how samples are degassed and measured using BET machine (Connelly, 2017). Desorption of sample is not included in the measurement process.

After the evacuation of the sampling tubes, a dead-volume measurement is done using an inert gas (Helium) where the result is used to correct the quantity of adsorbate adsorbed. The dead-volume gas is then again removed by vacuum through evacuation. Nitrogen gas will be pumped into the sampling tube where the gas will cover the external and the accessible internal pore surfaces of the samples (Connelly, 2017). The gas molecules will condense on the surface of sample particles and are said to be adsorbed, forming a thin layer that covered the whole surface of the material at cryogenic temperature (temperature around -196°C or 123K) when the sample-filled sampling tube is submerged into the liquid nitrogen during testing. With the slow continuous flow of nitrogen, multiple layers of gas molecules will gradually stack up in parallel to capillary condensation. The sample's surface area can be calculated by multiplying the number of gas molecules, v_m, with the cross-sectional area of an adsorbate molecule (Quantachrome Instrument, 2017). As the gas adsorption on the sample occurs, the pressure in the confined volume would continue to fall until the adsorbate and the adsorptive are in equilibrium. The difference between the amount of gas admitted and adsorptive remaining in gas phase is meant to be the amount of adsorbate at the equilibrium pressure (Connelly, 2017). When the equilibrium adsorbate pressures approach an approximate 100% saturation, the pores in the sample particles will completely be filled with adsorbate where the SSA measurement for the sample is estimated (Quantachrome Instrument, 2017) (Figure 18; Figure 19).

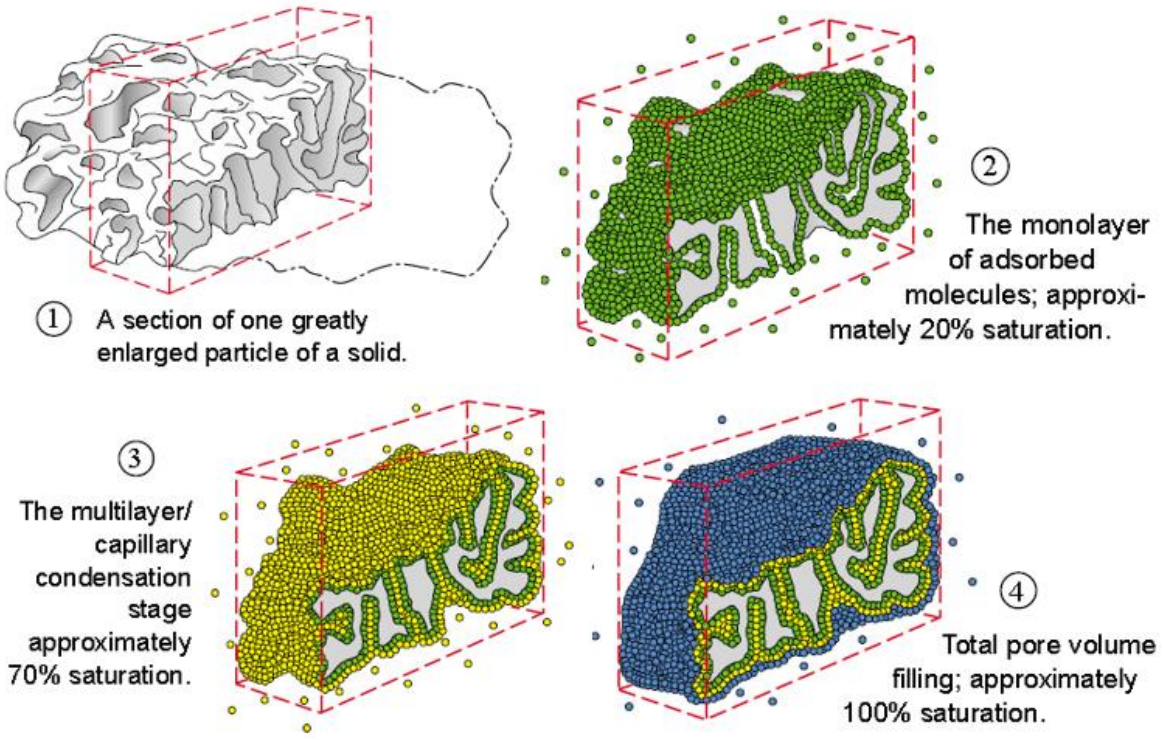


Figure 19: Schematic image showing the process of gas adsorption in the surface area of grain particles by starting to form a thin layer of adsorbed molecules until the pores are completely filled (Quantachrome Instrument, 2017).

A report consisting of a multipoint BET surface area plot is presented (Figure 20). A linear plot of $1/\{v[(p_o-p)-1]\}$ vs p/p_o is required in BET equation. The y-intercept and slope from this plot can be used in determining the volume of a monolayer of adsorbate, v_m and the constants, c = slope/y-intercept + 1.

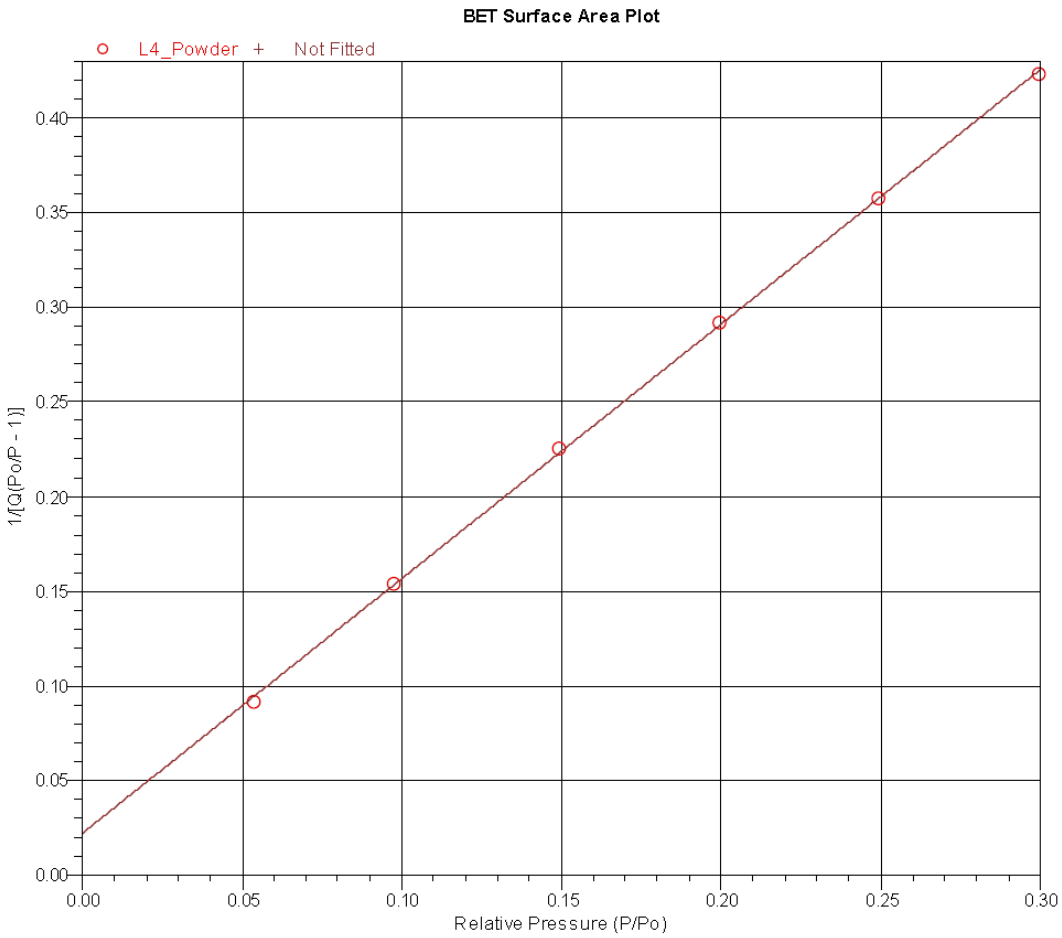


Figure 20: One of the sample's BET surface area plot that is generated for SSA analysis where the points can be used in BET equation.

The specific surface area, ***S*** can then be defined by the following equation

$$S = \frac{v_m NA}{22{,}400 \times m}$$

Where:

N : Avogadro's number (6.023 x 10^{23} molecules per mole)

A : the cross-sectional surface area of a single adsorbed gas molecule

m : mass of nanomaterials used in the measurement

22,400 : the Standard Temperature and Pressure (STP) of a mole of gas (Brame and Griggs, 2016)

Using the former approach where a multi-point BET (minimum of three points) would be introduced with the realization that a slight error would be introduced, the magnitude of adsorbent/adsorbate interactions will scale as the value of ***c*** decreases. ***c*** normally has the value around 100-200 for valid SSA measurements; if it is lower than 20, there is a high significant of adsorbent/adsorbate; if it is greater than 200, it may indicate large porosity volume in the sample (Anovitz and Cole, 2015; Connelly, 2017). The specific surface area that is calculated in units of area/mass (m^2/g) can be converted to a volume-specific surface area by multiplying with the density of sample.

3.3 Density Measurement

Density is a fundamental characteristic property that measures the degree of compactness and concentration of a material. Density (**ρ**) is defined where the mass of material, ***m***, is divided by its volume, **V**. Due to the irregular shape of the samples that are provided, a simple method is used in obtaining the rock volume by fully submerging the samples into a volume graduated beaker filled with water; samples like chalk that cannot be immersed in water are wrapped in cling wrap (Figure 21a) before the task is carried out. Water level, in millilitres, before and after the sample is submerged is recorded, and the difference of the water level is considered as a rough volume measurement for the rock sample (Figure 21b). Since the conversion factor for millilitres (ml) to cubic centimetres (cm^3) is 1, therefore 1ml = $1cm^3$.

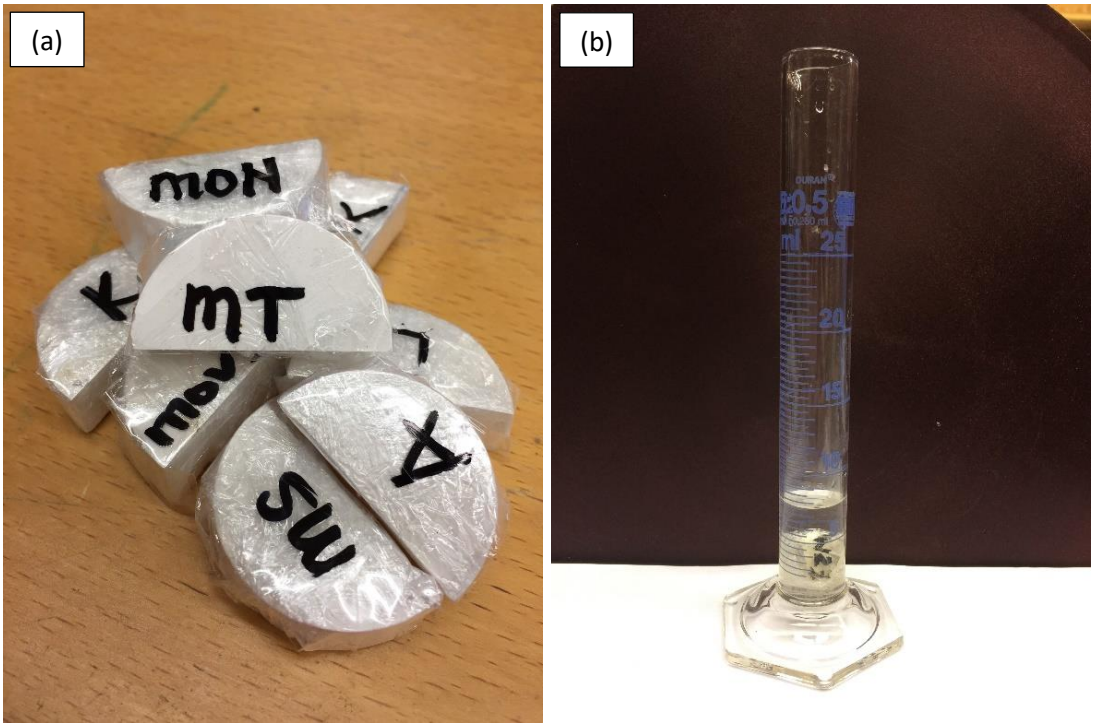


Figure 21: (a) The chalk samples are labelled after they are cling-wrapped and ready for volume measurement. (b) The chalk sample is then submerged into the water where the difference in water level is clearly shown.

3.4 Permeability Calculation

With related rock sample data such as porosity, SSA measurement, and density, estimated permeability can be calculated by implying the data into the standard Kozeny-Carman equation (Dvorkin, 2009; Kameda et al., 2006).

$$\mathbf{k} = \frac{\boldsymbol{\phi}^3}{2 \times \boldsymbol{S}_\mathbf{v}^{\,2} \times \boldsymbol{\tau}^2}$$

Where:

k : permeability, mD (= 1 x 10^{-16} m^2)

$\boldsymbol{\phi}$: porosity

$\boldsymbol{S}_\mathbf{v}$: specific surface area (volume), m^2/m^3

$\boldsymbol{\tau}$: tortuosity

In order to calculate permeability, SSA measurements need to be converted to volume-specific surface area that is mentioned previously using the value of SSA and density. Equations are expanded and collapsed for a better understanding on how the data values are being applied.

Volume-Specific Surface Area Calculation (m^2/m^3) : $\boldsymbol{S}_\mathbf{v} = \frac{\boldsymbol{S_0}}{\mathbf{V}}$

Specific Surface Area Measurement (m^2/g) : $\boldsymbol{S} = \frac{\boldsymbol{S_0}}{\boldsymbol{m}}$

Surface Area ($\boldsymbol{S_0}$) : $\boldsymbol{S_0} = \boldsymbol{S} \times \mathbf{m}$

Sample Volume : $\mathbf{V} = \frac{\mathbf{m}}{\boldsymbol{\rho}}$

By rearranging equations, a refined equation for volume-specific surface area is calculated.

$$\boldsymbol{S}_\mathbf{v} = \frac{\boldsymbol{S} \times \mathbf{m}}{\mathbf{V}} = \frac{\boldsymbol{S} \times \mathbf{m}}{\mathbf{m}/\boldsymbol{\rho}} = \boldsymbol{S} \times \boldsymbol{\rho}$$

The refined equation for $\boldsymbol{S}\mathbf{v}$ is then input into the Kozeny-Carman equation that is finalized as below.

$$\mathbf{k} = \frac{\boldsymbol{\phi}^3}{2 \times (\boldsymbol{S} \times \boldsymbol{\rho})^2 \times \boldsymbol{\tau}^2}$$

Tortuosity in the equation is defined as $\boldsymbol{\tau = \sin^{-1} a}$, often used to describe diffusion in porous media (Dvorkin, 2009). The tortuosity can vary based on the geometry of pore space (Kameda et al., 2006), and can also be defined by the actual length of the pore channels per distance between the length of the core. The length of pore channels is proportional to the value of tortuosity. High tortuosity value specifies that a dense rock has limited path for a fluid to flow through. If fluid can flow through the porous rock without any obstacles, tortuosity value shall approach the ideal result, 0, which hardly happens (Dvorkin, 2009). However, the tortuosity equal to 1, becomes a constant, is used in this calculation because the exact geometry of the pore spaces for all the samples are not known thus this value cannot be calculated.

Chapter 4: Results

Chalk core samples from Aalborg, Kansas, Liège, and Mons Basin are the primarily focused batch of samples because these are part of the main reservoir rock that has been used in other Improved Oil Recovery (IOR) experimental studies. SSA measurements from these chalk samples are contributed into the database from all the previous year studies. More chalk samples and other rock type samples are provided later during the course of this study in order to have a simple overview of SSA values and make comparisons.

4.1 SSA Measurement Results

4.1.1 Chalk

Based on the results of the SSA analysis (Table 1), Mons, Obourg St. Vaast pellet chalk has the highest specific surface area with an average 4.1m^2/g followed by Aalborg pellet chalk that has approximately 3.7m^2/g specific surface area. The SSA measurements for other chalk core samples range between 2.9m^2/g to 1.8m^2/g. In comparison to chalk in pellet form, the SSA measurements for all powdered chalk samples (Table 2) show a slight increase that is later presented and discussed in Chapter 5 (Figure 29). A section from some of the core samples is considered anomalous although the variation is not too large as can be seen clearly from the "SSA Result for Chalk Core Sample Section" plot (Figure 22; Figure 23). Results for samples that are reanalysed for various reasons are not included since they would induce a bias.

Sample	Formation	Abbreviation	Sample Mass (g)	SSA Result (m^2/g)
Aalborg	Tor Formation	A1	2.0409	3.8795
		A2	2.0109	3.8432
		A3	2.0321	3.7005
		A4	1.9984	3.7649
		A5	2.0501	3.2084
			2.0553	3.2403*
Kansas	Niobrara Formation	K1	2.0775	2.3790
			2.0934	2.3362*
		K2	2.0726	2.7169
		K3	2.1332	2.6241
		K4	2.1237	2.6183
		K5	2.0442	2.6147
Liège	Gulpen Formation	L1	2.0660	2.5984
		L2	2.1077	2.6157
		L3	2.0438	2.7667
		L4	1.9971	2.9163
		L5	2.0672	2.6618

Mons, limit Obourg Nouvelles	Nouvelles Formation	MON1	2.0182	2.0662
		MON2	2.0673	2.1666
		MON3	2.0346	2.2918
		MON4	2.1616	2.0688
		MON5	2.0413	1.9090
Mons, Obourg St. Vaast	Saint Vaast Formation	MOV1	2.0517	4.1194
		MOV2	2.0385	4.2044
		MOV3	2.0579	4.1459
		MOV4	2.0553	4.0986
		MOV5	2.0532	4.3004
Mons, Spiennes	Spiennes Formation	MS1	2.0799	2.5817
		MS2	2.0431	2.7572
		MS3	2.0846	2.8034
		MS4	2.0509	2.6963
			2.0748	2.6309*
		MS5	2.0902	2.8069
Mons, Trivières	Trivières Formation	MT1	2.0033	1.8185
		MT2	2.0584	1.8366
		MT3	2.1044	1.8136
		MT4	2.1302	1.8058
		MT5	2.1251	1.6542
		M10	2.4590	1.9483*
Stevns Klint	Tor Formation	SK1	1.9297	1.9453
			1.0528	2.0713*
		SK2	2.0314	1.7853
			1.1807	1.8990*
		SK3	1.9979	1.8064
			2.0019	1.7896*
		SK4	1.9461	1.8926
			1.9453	1.8022*
		SK5	1.9297	1.9453
			1.9280	1.9370*

Table 1: The SSA measurement results obtained for chalk samples snipped from chalk cores (Appendix A). (* = reanalysed for result accuracy; * = different core sample; * = tested for ~1 gram; * = Degassed for 5 hours)

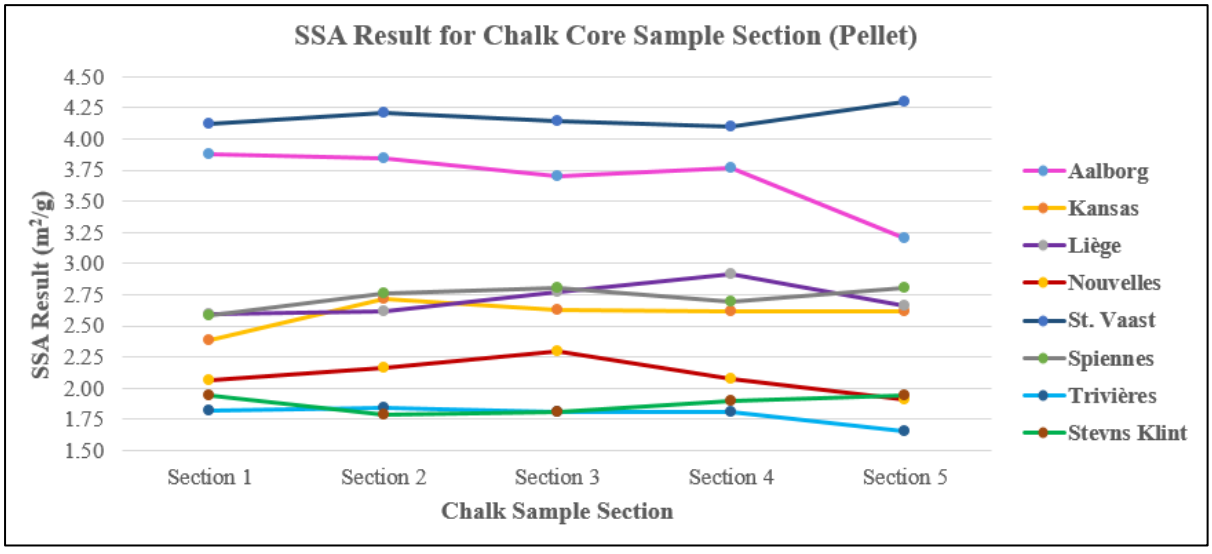


Figure 22: A plot showing SSA results for sections of different chalk core samples in pellet form.

Sample	Formation	Abbreviation	Sample Mass (g)	SSA Result (m^2/g)
Aalborg	Tor Formation	A1	2.0557	3.9960
		A2	2.0836	3.9358
		A3	2.0609	4.0128
		A4	2.0517	4.0097
		A5	2.1187	3.5009
Kansas	Niobrara Formation	K1	2.0555	2.7020
		K2	2.0864	3.0628
		K3	2.0486	2.9223
		K4	2.0510	2.9378
		K5	2.0683	2.9583
Liège	Gulpen Formation	L1	2.0352	2.9237
		L2	2.0661	2.9379
		L3	2.0607	3.0867
		L4	2.1296	3.1822
		L5	2.0400	3.0251
Mons, limit Obourg Nouvelles	Nouvelles Formation	MON1	2.2343	2.2727
		MON2	2.0269	2.4313
		MON3	2.0754	2.4592
			2.0808	2.5313*
		MON4	2.2227	2.2457
		MON5	2.0351	2.1095
Mons, Obourg St. Vaast	Saint Vaast Formation	MOV1	2.0409	4.5022
		MOV2	2.0696	4.5871
		MOV3	2.0634	4.4450
		MOV4	2.0422	4.4864
		MOV5	2.0518	4.5434
			2.1764	4.5252*
Mons, Spiennes	Spiennes Formation	MS1	2.0454	2.6921
		MS2	2.0581	2.8811
		MS3	2.0988	3.0166
		MS4	2.0892	2.8705
		MS5	2.1005	2.9431
Mons, Trivières	Trivières Formation	MT1	2.0811	2.0981
		MT2	2.0816	2.1582
		MT3	2.0723	2.1326
		MT4	2.0609	2.1039
		MT5	2.0476	1.9851
Stevns Klint	Tor Formation	SK1	2.0891	2.1185
		SK2	2.0670	2.0553
		SK3	2.0745	1.9555
		SK4	2.0480	1.9993
		SK5	2.0398	2.1053

Table 2: The SSA measurement results obtained for powdered chalk samples ground from chalk cores (Appendix B). (* = Degassed with 150°C)

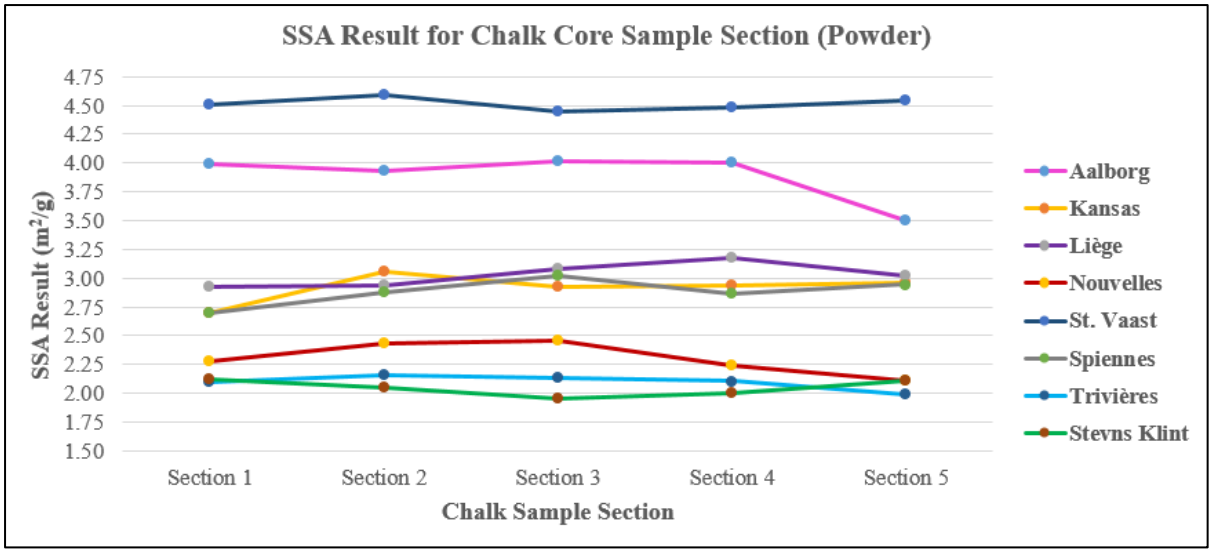


Figure 23: This plot presents SSA results for powdered chalk core samples in different sections that have a slight increase in values compare to pellet chalk samples' SSA results.

Other chalk cores collected previously for a different study from the same formations were flooded in $MgCl_2$ at simulated reservoir conditions for 2-3 months, were dried for twelve hours at 100°C and evacuated by vacuum prior to distilled water saturation. Only two of the flooded samples, Liège chalk and Kansas chalk, were selected for SSA analysis due to sample scarcity. The cores were divided into seven slices named s1-s7 (Figure 24) (Andersen et al., 2017).

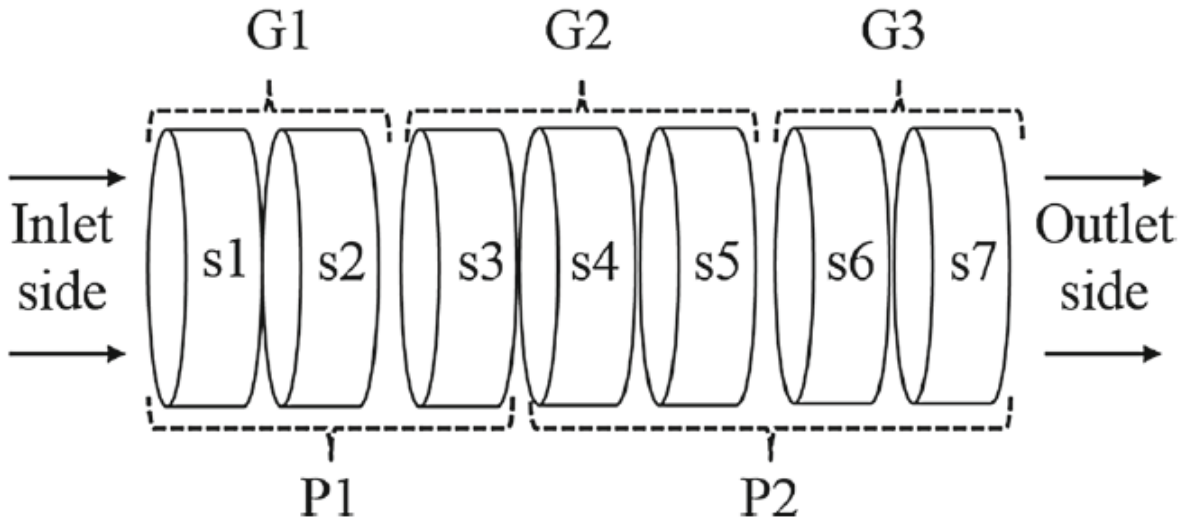


Figure 24: A schematic figure of sectioned core which were cut into seven slices, s1-s7 after flooding-compaction test. The arrows indicate flow direction (Andersen et al., 2017).

Sample	Section	Form	Sample Mass (g)	SSA Result (m^2/g)
L1-1(F)	First	Powder	1.9112	5.0301
L1-7(F)	Seventh (Last)		1.6289	2.8264
KA8-3(F)	Third (Mid)		1.8180	2.6893
KA8-7(F)	Seventh (Last)		1.3850	2.0445

Table 3: The SSA measurement results obtained for chalk samples flooded in $MgCl_2$ (Appendix C).

Referring to Table 3, the first (inlet) section of Liège chalk has a notable difference in SSA measurements as compared to the outlet (last) section. Even though the variation in SSA measurements for Kansas flooded chalk sections are negligible, the differences can be observed with non-flooded samples.

Sample	Formation/Member		Form	Sample Mass (g)	SSA Result (m^2/g)	Location
MAT K52	Mattinata Formation		Pellet	3.9370	1.6743	Eastern Italy
MAT K9				3.7997	0.3337	
MAT K6			Powder	1.7623	2.4371	
MAT K2			Pellet	3.2161	0.6070	
MAT K35			Powder	2.0162	2.5548	
MAT K1			Pellet	3.2605	0.8537	
VE13	Hod Formation		Pellet	3.4470	1.5820	North Sea
VE27	Tor Formation			1.0540	2.9240	
VE34			Powder	3.6246	1.2781	
VE37			Pellet	1.1590	1.8419	
VE50				2.8189	0.7951	
VE30				3.6430	1.4728	
VE29				3.7158	1.1930	
W3	Ulster White Limestone Formation	Cloghfin	Pellet	3.9779	1.2683	Northern Ireland
W13		Galboly South		3.2862	2.0238	
W23		Galboly North		3.4539	1.3394	
W24		Cloghastucan		3.7017	0.9269	
W19		Larry Bane		3.6051	0.6050	
W9		Glenarm		4.0453	0.5932	
W10		Garron		3.7132	0.7185	
W27		Portrush		3.7815	0.9363	
W18		Ballymagaree		3.8331	0.7694	
W15		Tanderagee		3.3103	0.9286	
W16		Port Calliagh		3.3436	1.1634	
W20		Ballycastle		3.8127	0.7895	

Table 4: The SSA measurement results obtained for chalk samples (from rock pieces) from different locations (Appendix D).

Another batch of chalk samples from separate locations were provided in the form of small rock portions, with varying grain sizes and sorting. These chalk samples show a variation in SSA measurement results even though they are from the same formation. A summary of the analysis clearly indicates that the Mattinata Formation chalk samples from Eastern Italy have SSA measurements range from $0.3m^2/g$ to $2.5m^2/g$; chalk samples from North Sea have SSA measurements range between $0.7m^2/g$ and $2.9m^2/g$; the SSA measurement results for Ulster White Limestone Formation (eleven members were tested) chalks are between $0.6m^2/g$ to $2.0m^2/g$. Detail information and measurements with regards to the above analysis is recorded in Table 4.

4.1.2 Sandstone and Carbonate

Sample	Formation	Sample Mass (g)	SSA Result (m^2/g)
01CV1	Catavi Formation	2.0962	0.5997
02CV2	Catavi Formation	2.0617	0.4383
03CV3	Catavi Formation	2.0747	0.8248
04CPA	Copacabana (sandstone) Formation	2.8315	0.8654
		2.0650	0.9161*
05CPL	Copacabana (siltstone) Formation	2.7971	5.2564
		2.0417	8.9518*
06CM	Cumaná Formation	2.0378	7.0066
08UN	Uncía Formation	2.0210	1.9016
09BE	Belén Formation	2.5214	2.1450
		2.0619	4.4335*
10CNC	Cancañiri Formation	2.0966	0.2951
11TQ	Tiquina Formation	2.0736	4.1357
12CPA2	Copacabana (sandstone) Formation	2.6005	9.0423
		2.0631	15.1079*
13AR	Aranjuéz Formation	3.1628	6.8920
		2.0664	9.9171*
14CL	Colpacucho Formation	2.0347	3.9431
15CHD	Chutani Formation (base)	2.0547	1.4938
016CHU	Chutani Formation (top)	2.3716	2.1104
		2.0735	1.7080*
075C	Sica-Sica Formation	2.0485	2.7591

Table 5: The SSA measurement results obtained for fresh rock samples from Bolivia in fragments (Appendix E). (* = Degassed with 300°C for two and a half hours)

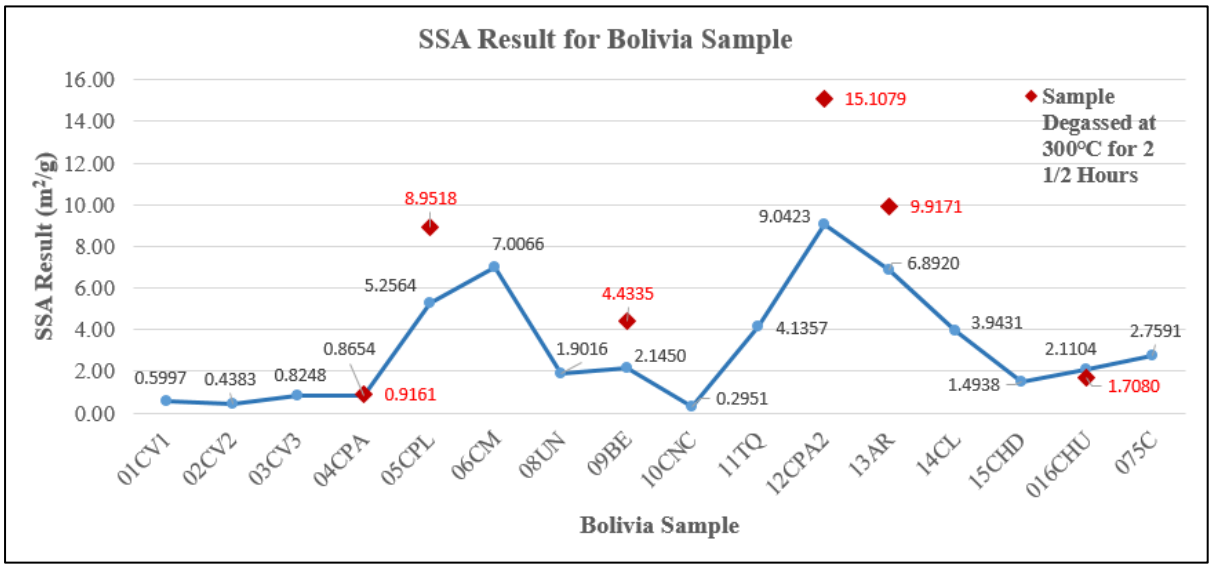


Figure 25: A simple plot showing SSA results for sample from Bolivia with additional results from reanalysed samples.

Bolivia samples consist of different rock types including sandstone, siltstone, mudstone, tuff, and more. Differences in grain sizes, compaction and sorting have influence the specific surface

area of the samples that reflected in the SSA measurement results. Comparing the sandstone samples from Copacabana Formation, 04CPA and 12CPA2, 12CPA2 has a very high SSA result of 9.0423m^2/g whereas 04CPA only has 0.8654m^2/g of SSA. The sample with the least SSA is 10CNC which is a tillite from Cancañiri Formation with only 0.2951m^2/g. However, with the similar lithology from Cumaná Formation which is diamictite, 06CM has a higher SSA measurement of 7.0066m^2/g. Since there are several of rock types with various SSA analysis results, Table 5 is presented with data and results for this subset of samples. On the other hand, sample 09BE that is degassed under high temperature of 300°C has a distinct increase in SSA measurement (Figure 25) of 4.4335m^2/g comparing to previous measurement of 2.1450m^2/g that is analysed under the set consistent condition.

Sample	Abbreviation	Formation	Sample Mass (g)	SSA Result (m^2/g)
Sandstone	SAL3	Mora Formation	3.1165	2.9821
Quartz Arenite	HE14	Herrería Formation	2.8987	18.9468
Dolomite	LD	Láncara Formation	3.0240	1.7129
Limestone	L13		3.3242	1.2069
Griotte	G18		2.0066	3.7092
Shale	OV7	Oville Formation	2.3517	9.7963
Sandstone	B4	Barrios Formation	3.4853	1.2314
Tuff	BT		2.9705	11.9177
Sandstone	SP7	San Pedro Formation	4.1611	3.4121
Pedrosa Limestone	LV3	Pedrosa Formation	2.5558	24.0314
Coladilla Limestone	CollaD	Coladilla Formation	3.8123	4.7818
Limestone	SLL	Santa Lucía Formation	3.5718	2.6110
Sandstone	HU7	Huergas Formation	2.9546	16.4913
Limestone Reef	Portilla	Portilla Formation	3.0474	3.2907
Limestone	SE6	San Emiliano Formation	2.6117	19.8770
Limestone	Gijón	Gijón Formation	3.0870	1.9259
Limestone	Rodiles	Rodiles Formation	2.3972	24.4699
Sandstone	Vega	Vega Formation	4.5543	1.5429
Conglomerate	VC		4.3912	2.0897

Table 6: The SSA measurement results obtained for powder samples from Spain that was tested in 2013 (Appendix F).

Similar to the samples from Bolivia, Spain samples are collections of different rock types. Pedrosa limestone and Rodiles limestone have approximately same SSA result, 24m^2/g. There are two lithology in Barrios Formation, crystallized sandstone and tuff, with SSA results of 1.2314m^2/g and 11.9177m^2/g. From Table 6, it is very obvious that although the samples have the same lithology i.e. limestone, the SSA result for each sample varies. The SSA results for

these nineteen samples range between 1m^2/g to 24m^2/g which are presented in a plot according to lithology (Figure 26).

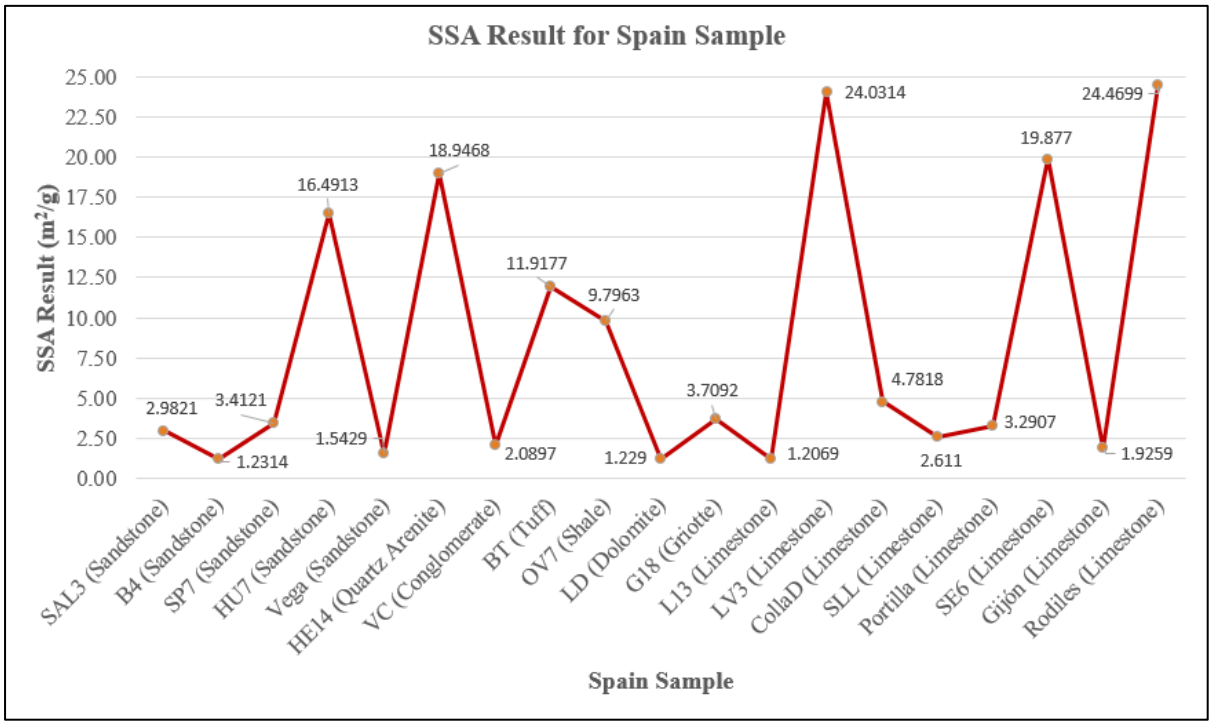


Figure 26: This plot presents the SSA results for Spain samples in powder form according to rock types.

4.1.3 Other Rock Types

Sample	Abbreviation	Formation	Form	Sample Mass (g)	SSA Result (m^2/g)
Tillite	335	Guandacol Formation	Mixture (Powder and Little Fragments)	5.3645	3.0870
Salt	SDA	-		3.0171	0.3781
Dacite	Tul Tul	-		3.2434	1.9224
Tuff	PAY	-		2.9282	2.8176
	I62	-		3.0603	3.1212
	LN	-		2.8264	0.8236
	Galan	-		3.2995	2.5592

Table 7: The SSA measurement results obtained for samples that are collected from different South America locations (Appendix G).

This is a small batch of samples with different rock types from South America which are so far not classified in terms of formation names and were added to have a wider range of lithology (Table 7). Salt (SDA) has the least SSA with only 0.3781m^2/g and tuff I62 has the highest SSA measurement of 3.1212m^2/g among these samples. However, there is also a tuff sample with very low SSA measurement, 0.8236m^2/g that is quite similar to salt's specific surface area.

A few samples had re-analysed SSA measurements for several reasons which are documented within Table 1, Table 2, and Table 5 (Appendix H). Some of the results from the revised

analyses have similarity with the previous results which shows the reliability of results that are obtained such as sample A5, K1 and MS4. A considerable number of factors that affect the physical or chemical characteristics of the material are reflected in the variation of SSA results. Variations of the results are discussed in detail in the later part of this thesis.

4.2 Density of Samples

A fundamental calculation of density is required since it is used in the permeability equation, the Kozeny-Carman equation. For several samples density was available from previous studies while for others (forty samples) density was calculated in the laboratory as explained previously in Chapter 3. The density of chalk samples that are received in core are comparable and ranges from 1.08g/cm^3 to 1.25g/cm^3. For other chalk samples, the density has a wider variation ranging between 0.97g/cm^3 and 3.30g/cm^3. The small pieces of chalk sample W9 has the highest density due to its high hardness influenced by compaction of materials. On the other hand, sample PAY has a lower density compare to sample W9 despite its bigger size as a result of its frail texture that causes it to break apart easily. This has proven that sample size does not determine the sample density where all the density measurements are listed in Appendix J.

4.3 Permeability Results

Sample	Form	SSA (m^2/g)	Porosity (%)	Density (g/cm^3)	Permeability (mD)
A1	Pellet	3.8795	46.5	1.24	2.1724×10^1
	Powder	3.9960			2.0476×10^1
A2	Pellet	3.8432			2.2136×10^1
	Powder	3.9358			2.1107×10^1
A3	Pellet	3.7005			2.3876×10^1
	Powder	4.0128			2.0304×10^1
A4	Pellet	3.2403			3.1140×10^1
	Powder	3.7649			2.3066×10^1
A5	Pellet	3.2084			3.1762×10^1
	Pellet	3.2403			3.1140×10^1
	Powder	3.5009			2.6676×10^1
K1	Pellet	2.3790	37.0	1.24	2.9103×10^1
	Pellet	2.3362			3.0180×10^1
	Powder	2.7020			2.2561×10^1
K2	Pellet	2.7169			2.2314×10^1
	Powder	3.0628			1.7559×10^1
K3	Pellet	2.6241			2.3921×10^1
	Powder	2.9223			1.9288×10^1
K4	Pellet	2.6183			2.4027×10^1
	Powder	2.9378			1.9085×10^1

K5	Pellet	2.6147			2.4093×10^{1}
	Powder	2.9583			1.8821×10^{1}
L1	Pellet	2.5984	43.3	1.10	4.9686×10^{1}
	Powder	2.9237			3.9245×10^{1}
L2	Pellet	2.6157			4.9031×10^{1}
	Powder	2.9379			3.8866×10^{1}
L3	Pellet	2.7667			4.3825×10^{1}
	Powder	3.0867			3.5210×10^{1}
L4	Pellet	2.9163			3.9444×10^{1}
	Powder	3.1822			3.3128×10^{1}
L5	Pellet	2.6618			4.7348×10^{1}
	Powder	3.0251			3.6658×10^{1}
MON1	Pellet	2.0662	43.3	1.21	6.4941×10^{1}
	Powder	2.2727			5.3676×10^{1}
MON2	Pellet	2.1666			5.9062×10^{1}
	Powder	2.4313			4.6901×10^{1}
MON3	Pellet	2.2918	43.3	1.21	5.2785×10^{1}
	Powder	2.4592			4.5843×10^{1}
	Powder	2.5313			4.3269×10^{1}
MON4	Pellet	2.0688			6.4778×10^{1}
	Powder	2.2457			5.4974×10^{1}
MON5	Pellet	1.9090			7.6077×10^{1}
	Powder	2.1095			6.2302×10^{1}
MOV1	Pellet	4.1194	40.1	1.25	1.2160×10^{1}
	Powder	4.5022			1.0180×10^{1}
MOV2	Pellet	4.2044			1.1673×10^{1}
	Powder	4.5871			9.8063
MOV3	Pellet	4.1459			1.2005×10^{1}
	Powder	4.4450			1.0443×10^{1}
MOV4	Pellet	4.0986			1.2283×10^{1}
	Powder	4.4864			1.0252×10^{1}
MOV5	Pellet	4.3004			1.1158×10^{1}
	Powder	4.5434			9.9959
	Powder	4.5252			1.0076×10^{1}
MS1	Pellet	2.5817	40.3	1.08	4.2001×10^{1}
	Powder	2.6921			3.8627×10^{1}
MS2	Pellet	2.7572			3.6824×10^{1}
	Powder	2.8811			3.3725×10^{1}
MS3	Pellet	2.8034			3.5620×10^{1}
	Powder	3.0166			3.0763×10^{1}
MS4	Pellet	2.6963			3.8506×10^{1}
	Pellet	2.6309			4.0444×10^{1}
	Powder	2.8705			3.3974×10^{1}
MS5	Pellet	2.8069			3.5532×10^{1}
	Powder	2.9431			3.2319×10^{1}
MT1	Pellet	1.8185	41.0	1.22	7.0013×10^{1}
	Powder	2.0981			5.2596×10^{1}
MT2	Pellet	1.8366			6.8639×10^{1}

MT2	Powder	2.1582	41.0	1.22	4.9707×10^{1}
MT3	Pellet	1.8136			7.0391×10^{1}
	Powder	2.1326			5.0908×10^{1}
MT4	Pellet	1.8058			7.1001×10^{1}
	Powder	2.1039			5.2306×10^{1}
MT5	Pellet	1.6542			8.4611×10^{1}
	Powder	1.9851			5.8754×10^{1}
M10	Pellet	1.9483			6.0994×10^{1}
SK1	Pellet	1.8972	46.5	1.19	9.8630×10^{1}
	Pellet	2.0713			8.2747×10^{1}
	Powder	2.1185			7.9100×10^{1}
SK2	Pellet	1.8990			9.8443×10^{1}
	Pellet	1.7853			1.1138×10^{2}
	Powder	2.0553			8.4040×10^{1}
SK3	Pellet	1.8064			1.0880×10^{2}
	Pellet	1.7896			1.1085×10^{2}
SK3	Powder	1.9555	46.5	1.19	9.2837×10^{1}
SK4	Pellet	1.8926			9.9110×10^{1}
	Pellet	1.8022			1.0932×10^{2}
	Powder	1.9993			8.8814×10^{1}
SK5	Pellet	1.9453			9.3813×10^{1}
	Pellet	1.9370			9.4618×10^{1}
	Powder	2.1053			8.0095×10^{1}
L1-1(F)	Powder	5.0301	43.3	1.10	1.3259×10^{1}
L1-7(F)	Powder	2.8264			4.1993×10^{1}
KA8-3(F)	Powder	2.6893	37	1.24	2.2775×10^{1}
KA8-7(F)	Powder	2.0445			3.9406×10^{1}
MAT K9	Pellet	0.3337	7.36	1.88	5.0650
MAT K6	Pellet	2.4371	6.90	1.83	8.2579×10^{-2}
MAT K2	Pellet	0.6070	28.45	1.91	8.5659×10^{1}
MAT K35	Pellet	2.5548	18.00	0.97	4.7482
MAT K1	Pellet	0.8537	4.37	1.36	3.0955×10^{-1}
VE13	Pellet	1.5820	13-25	1.36	6.2994
VE27	Pellet	2.9240	13.00	1.20	8.9224×10^{-1}
VE34	Powder	1.2781	13.00	1.22	4.5181
VE37	Pellet	1.8419	37.00	1.40	3.8088×10^{1}
VE50	Pellet	0.7951	19.00	1.15	4.1020×10^{1}
VE30	Pellet	1.4728	15.00	1.69	2.7239
VE29	Pellet	1.1930	9.00	1.64	9.5220×10^{-1}
W3	Pellet	1.2683	2.36	1.52	1.7684×10^{-2}
W13	Pellet	2.0238	12.91	1.18	1.8865
W23	Pellet	1.3394	8.44	1.73	5.5987×10^{-1}
W24	Pellet	0.9269	1.08	2.06	1.7276×10^{-3}
W19	Pellet	0.6050	4.91	2.68	2.2513×10^{-1}
W9	Pellet	0.5932	1.23	3.30	2.4280×10^{-3}
W10	Pellet	0.7185	1.45	1.84	8.7214×10^{-3}
W27	Pellet	0.9363	5.30	2.80	1.0831×10^{-1}
W18	Pellet	0.7694	11.22	1.83	3.5624

W15	Pellet	0.9286	11.55	1.37	4.7601
W16	Pellet	1.1634	17.36	2.18	4.0668
W20	Pellet	0.7895	7.44	1.48	1.5082
01CV1	Fragments	0.5997	1.77	2.57	1.1672×10^{-2}
02CV2	Fragments	0.4383	0.71	2.64	1.3366×10^{-3}
03CV3	Fragments	0.8248	0.59	2.71	2.0554×10^{-4}
04CPA	Fragments	0.9161	0.68	2.66	2.6476×10^{-4}
		0.8654			2.9669×10^{-4}
05CPL	Fragments	8.9518	13.65	2.30	2.9998×10^{-2}
		5.2564			8.7003×10^{-2}
06CM	Fragments	7.0066	2.24	2.66	1.6178×10^{-4}
08UN	Fragments	1.9016	0.76	2.78	7.8539×10^{-5}
09BE	Fragments	4.4335	4.79	2.54	4.3333×10^{-3}
		2.1450			1.8512×10^{-2}
10CNC	Fragments	0.2951	13.62	2.65	2.0658×10^{1}
11TQ	Fragments	4.1357	9.99	2.55	4.4822×10^{-2}
12CPA	Fragments	15.1079	9.00	2.43	2.7044×10^{-3}
		9.0423			7.5497×10^{-3}
13AR	Fragments	9.9171	10.22	2.41	9.3437×10^{-3}
		6.8920			1.9346×10^{-2}
14CL	Fragments	3.9431	5.80	2.53	9.8025×10^{-3}
15CHD	Fragments	1.4938	0.62	2.64	7.6622×10^{-5}
16CHU	Fragments	1.7080	1.46	2.71	7.2630×10^{-4}
		2.1104			4.7573×10^{-4}
075C	Fragments	2.7591	4.12	2.58	6.9006×10^{-3}
SAL3	Powder	2.9821	2.50	2.62	1.2770×10^{-3}
HE14	Powder	18.9468	11.47	2.35	3.8156×10^{-3}
LD	Powder	1.7190	0.694	2.87	6.8808×10^{-5}
L13	Powder	1.2069	0.696	2.72	1.5678×10^{-4}
G18	Powder	3.7092	0.918	2.71	3.8107×10^{-5}
OV7	Powder	9.7963	7.38	2.45	3.4917×10^{-3}
B4	Powder	1.2314	1.41	2.53	1.4452×10^{-3}
BT	Powder	11.9177	5.60	2.47	1.0109×10^{-3}
SP7	Powder	3.4121	4.13	2.89	3.6248×10^{-3}
LV3	Powder	24.0314	1.93	2.86	7.6106×10^{-6}
CollaD	Powder	4.7818	1.78	2.72	1.6717×10^{-4}
SLL	Powder	2.6110	1.54	2.71	3.6235×10^{-4}
HU7	Powder	16.4913	7.84	2.48	1.4382×10^{-3}
Portilla	Powder	3.2907	0.738	2.72	2.5072×10^{-5}
SE6	Powder	19.8770	5.43	2.48	1.1385×10^{-5}
Gijón	Powder	1.9259	1.60	2.69	7.5851×10^{-5}
Rodiles	Powder	24.4699	1.91	2.68	8.1440×10^{-6}
Vega	Powder	1.5429	11.85	2.34	6.3993×10^{-1}
VC	Powder	2.0897	6.67	2.46	5.5963×10^{-2}

Table 8: Permeability of samples are calculated from porosity, density, and SSA results for all the samples.

Almost all the samples are provided with porosity information. Based on the provided porosity information an inferred permeability can be calculated as explained in Chapter 3.4. Referring

to Table 8, sample SK1-SK5 has the highest permeability where one of the measurement peaked at 1.1138×10^{2} mD while the general average permeability is 9.5506×10^{1} mD. Contrarily, a sample from Rodiles Formation has permeability as low as 8.1440×10^{-6} mD. All the chalk samples on average have similar permeability results around 2.5 to 3.5×10^{1} mD whereas the permeability measurements for other rock types are not consistent due to large variation which are shown in Table 8. For example, sample 10CNC has permeability of 2.0658×10^{1} mD while sample G18 presents a permeability of 3.8107×10^{-5} mD.

Chapter 5: Analytical Issues when Measuring Specific Surface Area

The result section already shows that more tests are paramount to have a better understanding of how porosity, density, SSA, and permeability of the samples are related to each other and facilitate a means to estimate reservoir conditions. Nonetheless, there are other factors that can affect these parameters and eventually influence the reservoir framework that shall be discussed first, before a possible exhaustive interpretation would be meaningless.

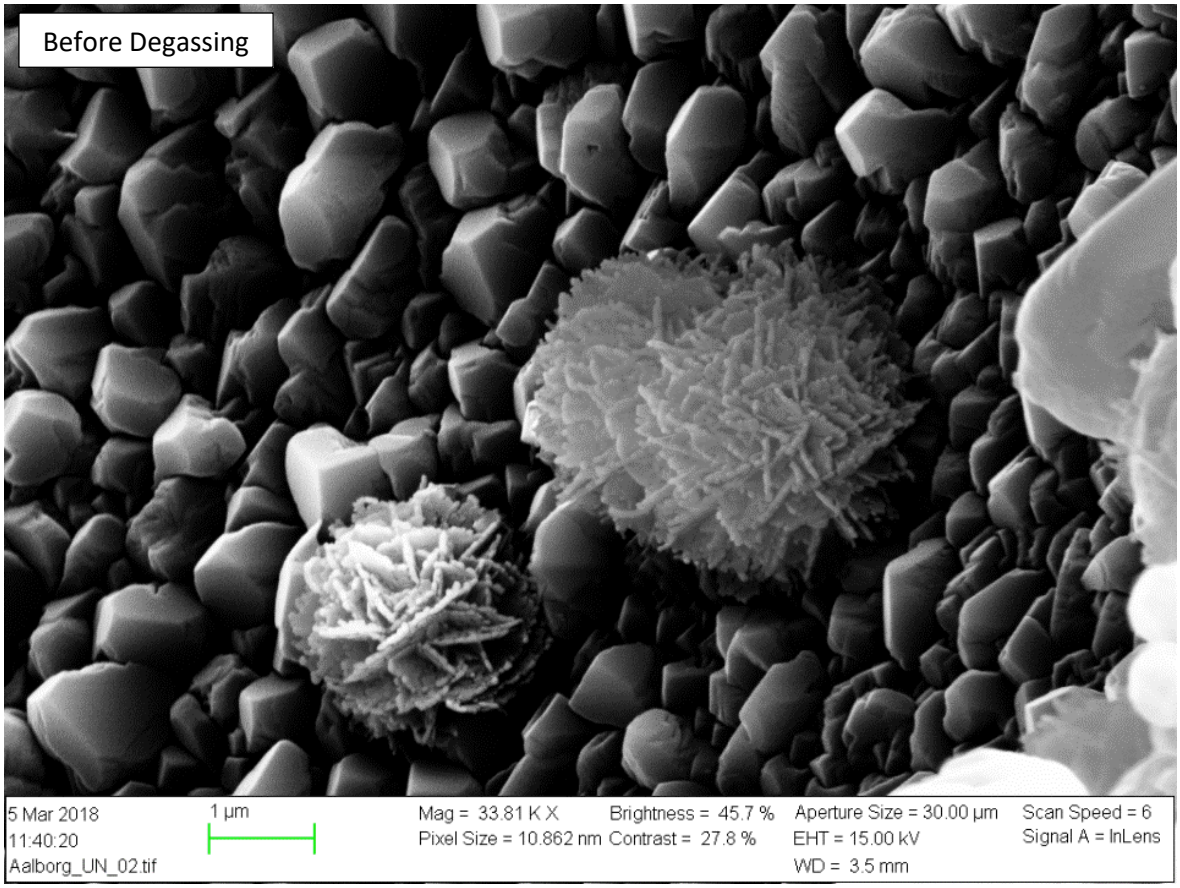
5.1 Sample Storage

The samples in the laboratory are not optimally preserved when compared to their source conditions which may have a considerable environmental effect on the samples. To reduce errors and flaws in the calculations, sample preparation needs to be done with caution to correct for environment conditions and is practised in routine for all samples. In addition, systematic errors that are related to equipment precision and calculations can be reduced by maintaining strict process guidelines facilitated with repeated analysis to acquire averaged results.

5.2 Sample Degassing

As mentioned previously in the methodology chapter, it is compulsory to remove impurities or moistures in the sample through degassing process. If this step is not performed, the specific surface area measurements can be low and non-reproducible since an indeterminate amount of surface will be covered with foreign substance (Micromeritics). However, the temperature that is suitable for degassing depending on rock type is hard to determine. In order to ascertain how heating has affected the sample's physical condition, a scanning electron microscope (SEM) analysis is performed on Aalborg chalk sample before and after degassing.

Aalborg chalk dominantly contains 92-94 wt% calcite with traces of illite/smectite with scarce gibbsite and quartz. This sample has the most considerable fraction of SiO_2 in the form of opal-CT which is not found in other chalk types (Andersen et al., 2017). The opal-CT before degassing as shown in Figure 27 is spherically made up of tiny microcrystalline blades with high water content. These microcrystalline blades are able to contribute to a higher specific surface area. With heat supplied during degassing, it is a high risk for opal-CT to be defected while eliminating the moisture. The defect crystals that are circled in red (Figure 27) can be seen clearly with broken blades and imperfect spheres. These defects have deliberately altered the SSA measurements.



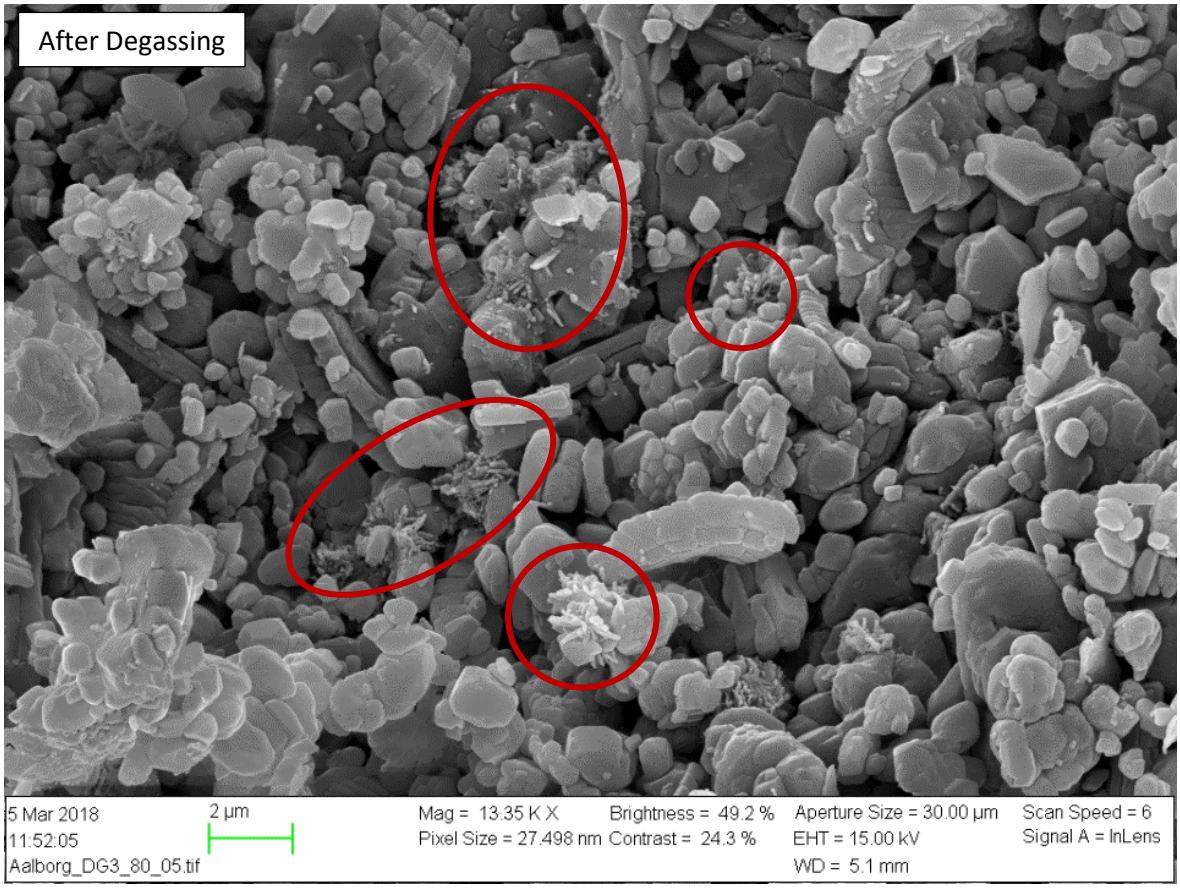


Figure 27: The Aalborg chalk sample has undamaged opal-CT crystals before degassing while some of the opal-CT are broken apart after the process of degassing.

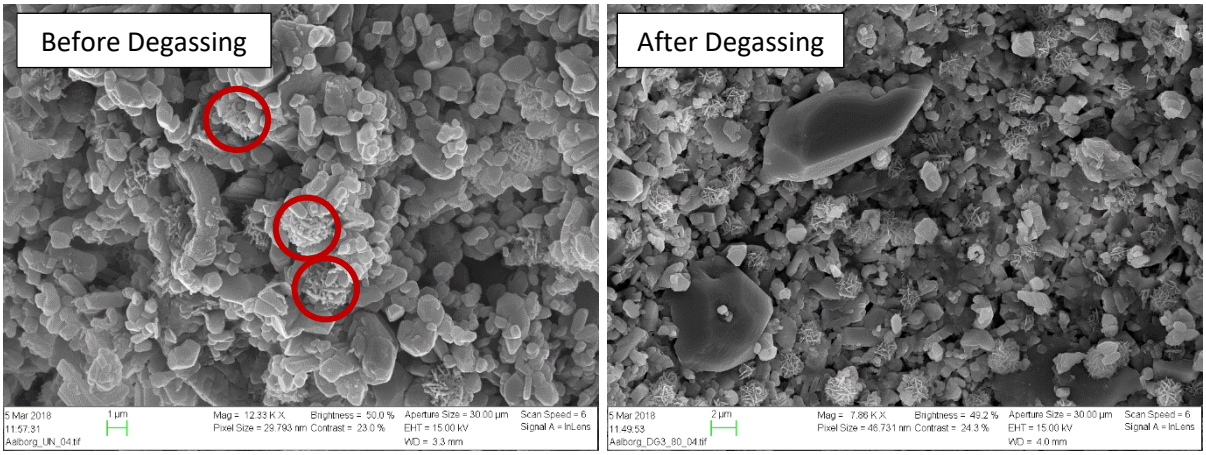


Figure 28: Opal-CT without perfect microcrystalline blades are found in the non-degassed sample where ideally grown opal-CT can still be seen after degassing.

In spite of previous discussions, opal-CT without microcrystalline blades (Figure 28 with red circles) are identified in the non-degassed sample whereas perfectly grown opal-CT are found in the degassed sample. This may indicate that some of the opal-CT are not damaged due to the degassing, it is assumed that the opal-CT crystals are immaturely developed and thus the blades are yet to grow. This has created an uncertainty whether degassing actually caused the deformity of the sample and may thus influence the SSA measurements.

5.3 Altering Sample Consistency during SSA Analysis

5.3.1 Sample Degassed with Higher Temperature (150°C and 300°C)

It is understood that samples that are degassed in excessively high temperatures would indeed make changes to the samples. Changes to the samples can be reflected in the results of SSA measurements. Sample MON3 and MOV5 (powder form) are re-degassed with 150°C where the results for SSA analysis are 2.5313m^2/g and 4.5252m^2/g (Table 2). Comparing with samples degassed in a lower temperature, the measurements do not vary that much which indicates that the samples are highly expected not deformed.

Nevertheless, there is a set of samples from Bolivia that are degassed in 300°C instead of 150°C for two and a half hours and show great differences in SSA measurements that are presented in Table 5. These samples that are degassed in high temperature have higher SSA measurement result which may be cause by two possibilities: (i) a lot more moisture and gas are expelled that allow better SSA analysis (ii) thermal expansion of minerals.

Under the influence of temperature, contact surfaces between particles are increasingly dependent on the thermal expansion of minerals. This leads to structural changes which impact

the values of strength parameters and physical properties including shape, volume, mass, and velocity of propagation of elastic waves through the rock medium. Furthermore, polymorphic transformation, melting, and disappearance of certain minerals occur as the chemical deformations of samples (Sygała et al., 2013). When a mineral expands, the mineral will have a larger size and forces other minerals around it to tension outward whereby more pores are created. Since porosity has increased, this will result in the increase of sample's SSA.

5.3.2 Sample Degassed for a Longer Time

Sample SK3-SK5 are reanalysed at similar volume/mass and temperature (80°C) for a longer time of five hours instead of three hours. SSA results shows that there is a slight increase from the result in Table 1, with the average of $0.05m^2/g$. The longer period of degassing has contributed to a better dehydrating of samples with composition preserved which in effect increases the surfaces for molecular adsorptions. If the sample is not dried sufficiently, the moisture will impact the surface interaction with the nitrogen gas negatively (Borch, 2016).

5.3.3 Effects of Sample Weight

Although volume of sample is more important in SSA analysis, at least one gram of sample is needed as the equipment requires a minimum sample weight of one gram. One gram of sample is considered in this analysis because some of the samples have limited material availability. Sample SK1 and SK2 are used in this re-analysis and found out that the SSA measurements have a minor increase. With approximately two grams of chalk sample, SSA measurements results for SK1 and SK2 are $1.9453m^2/g$ and $1.7853m^2/g$ while the results increase to $2.0713m^2/g$ and $1.8990m^2/g$ respectively with decreasing sample mass (Table 1).

With lesser sample mass which hardly fill up half of the "bulb" in the sampling tube, there is more void space in the sampling tube due to which a fill rod was used as a volume displacement device to reduce the free space. This extra void space is able to produce higher SSA measurement which is considered a slight error related to equipment precision. The result of SSA analysis for samples that are measured using a one gram can be added with the average variation of $0.1m^2/g$ in order to reduce this minor measurement error. However, this is a worthless step since the variation is not valid for the other samples.

Chapter 6: Implications of SSA Measurement Results

6.1 Comparisons of SSA Measurement Results

6.1.1 Chalk Pellet versus Chalk Powder

Each section of the chalk core samples is analysed for SSA measurements where the results are averaged to achieve the best fit values. However, a SSA value from a core cannot represent a bed of rock formation as a whole. An experiment has been conducted where another chalk core sample (pellet type) from Trivières Formation is analysed to present a value of 1.9483m^2/g (Table 1), that is larger than average measurement of 1.7857m^2/g (Figure 29) from the previous core sample. More samples need to be collected from different parts of formation and numerous analysis repetitions need to done to attain the bulk average in order to diminish the errors. However, this is not practiced in this study as there are large varieties of rock types with samples only collected from a certain part of bed rock and is very time intensive.

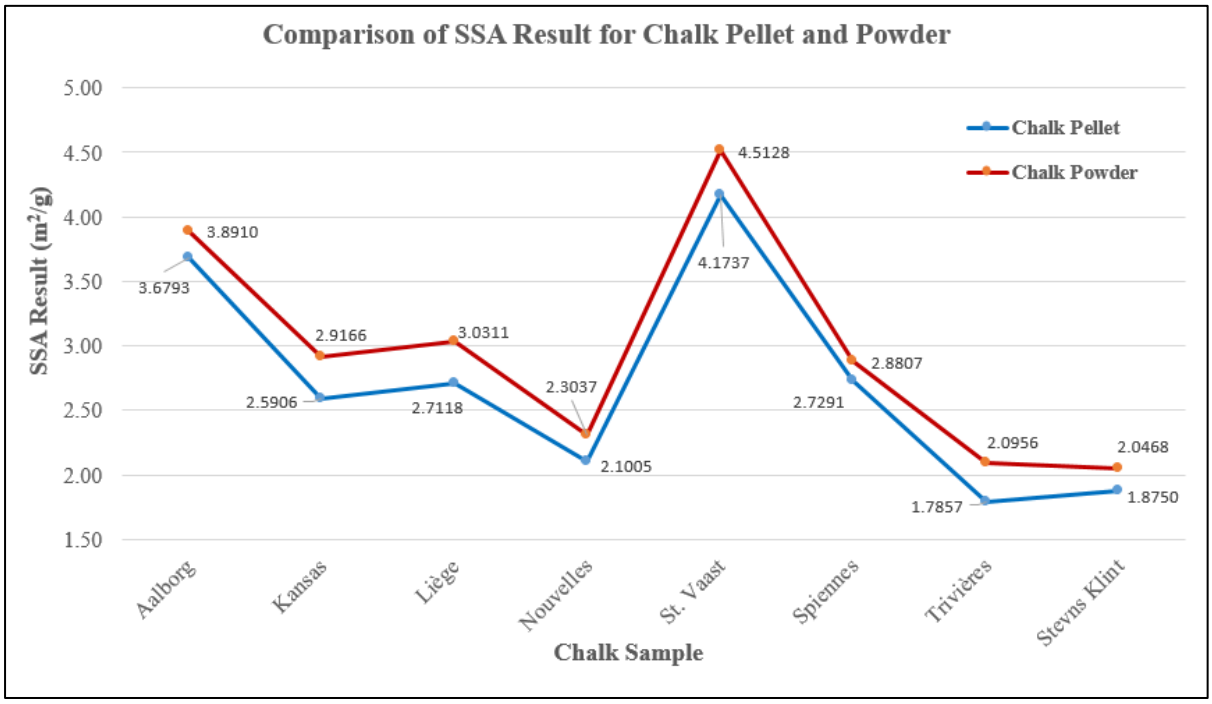


Figure 29: A graph comparing the SSA measurements of chalk pellet and powder has shown that chalk pellet (blue line) has a lower value compare to chalk powder (red line).

Based on the average results between pellet and powder, it is noticeable that samples in powder form present higher values (red line in Figure 29). Through these results, it is proven that smaller particles have larger specific surface area to volume ratios as mentioned previously in Chapter 1. The values are plotted in a graph against each other that shows a distinct variation ranging from 0.15m^2/g to 0.34m^2/g. Though the variation is perceived very small with just

0.15m^2/g, the surface area is considered to be an A0 paper size with a gram of sample. Based on this estimation, an outcrop will have millions to trillions m^2 of specific surface area depending on rock types that is able to adsorb and contain hydrocarbon in a potential reservoir.

6.1.2 Unflooded Chalk versus Flooded Chalk

Liège and Kansas chalk with calcite content around 95-97 wt% was flooded with simplified brine, 0.219mol/L $MgCl_2$ at 130°C while compacting in a creep state. First (inlet) and the last sections (outlet) of flooded Liège chalk samples (powder form) while middle and outlet sections of flooded Kansas chalk samples (powder form) are provided for SSA analysis. All the chalk samples show that the calcite grains are corner-rounded indicating dissolution after brine flooding with intact microfossils and coccolithophores preserved. Besides, crystals of magnesite, $MgCO_3$ have precipitated in hexagonal or trigonal shape. Euhedral magnesite crystals were not discovered after the middle section for Liège chalk, however these crystals could only be found in the inlet section of Kansas chalk (Andersen et al., 2017).

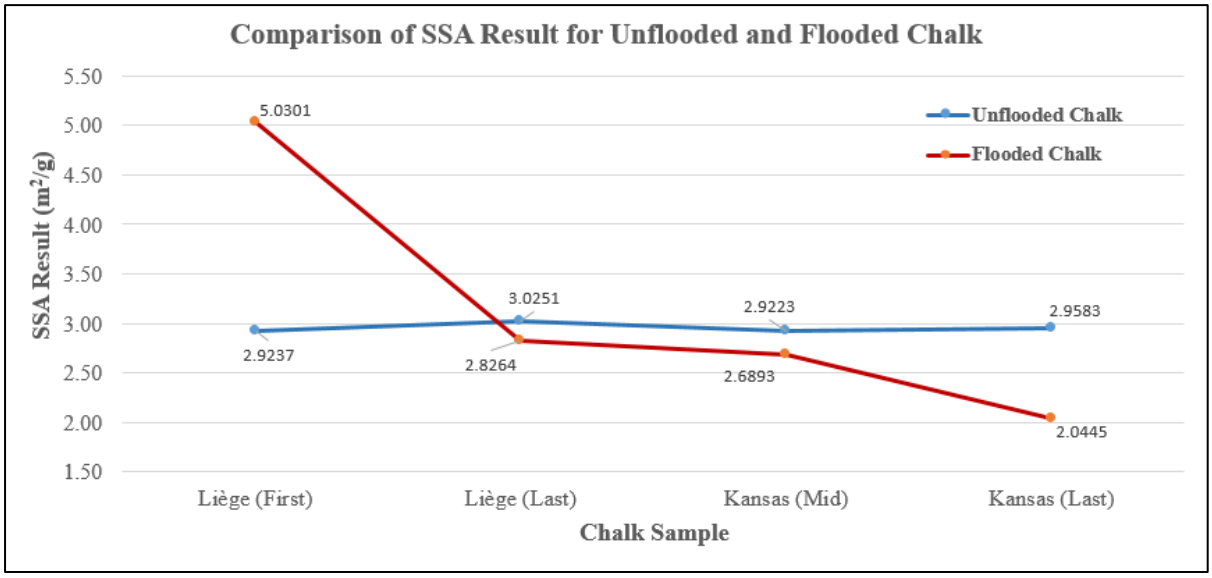


Figure 30: The SSA measurement results for unflooded and flooded chalk have been plotted into graph which indicates the influence of brine.

The inlet section of flooded Liège chalk shows a high value for SSA at 5.0301m^2/g while the outlet section has a lower value compared to the unflooded sample. This is due to high precipitation of magnesite crystals in the inlet section that create abundant specific surface area. Even though magnesite crystals are not observed in the outlet section of flooded Liège chalk, dissolution of grains had caused the reduction of specific surface area.

For flooded Kansas chalk, both middle and last sections present a decrease in SSA measurement where the value variations increase towards the outlet section. The reason of the

increasing variations cannot be certified but the decrease of measurements is definitely influenced by the grain dissolutions, equal to flooded Liège chalk. Comparisons of the data are presented as a plot in Figure 30.

6.1.3 2013 SSA Results versus 2018 SSA Results

Samples from Spain are reanalysed in this study as understanding SSA measurement is not the main focus during the Bachelor's thesis, instead are the methods of obtaining the results.

Distinct variables between SSA measurements of samples in 2013 (Appendix I) and 2018 are clearly displayed in a plot (Figure 31) where values from both years are compared. There are only a few samples that have similar SSA results such as Láncara limestone (L13), Barrios quartz arenite (B4), Vega sandstone (Vega), and Vega conglomerate (VC). With high similarity in these results, the SSA results are considered trustworthy. On the other hand, high fluctuations in SSA measurements are too astonishing which caused scepticism are shown in samples like Herrería quartz arenite (HE14), Oville shale (OV7), Pedrosa limestone (LV3), Huergas sandstone (HU7), San Emiliano limestone (SE6), and Rodiles limestone (Rodiles). One of the examples is sample LV3 with SSA result of 0.665m^2/g in year 2013 while the value has increased exceptionally to 24.0314m^2/g in this study. The difference of these measurements is 23.3664m^2/g which is almost 36 times more than the older value.

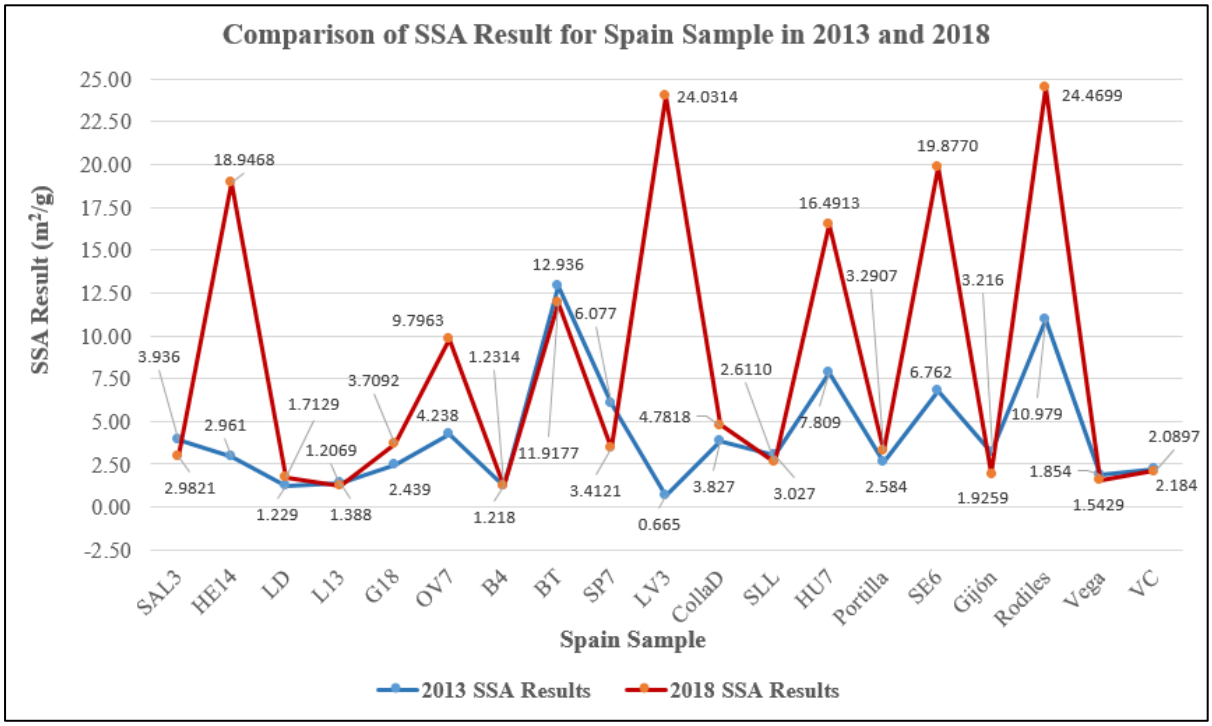


Figure 31: This plot presents diversity of SSA measurements which has variables ranging from as low as 0.02m^2/g to as high as 23.0m^2/g.

Overall, the measurement values do not follow a consistent trend; the older values show common deviation when compared with the recent values.

From these inequalities of values, it is likely that inconsistencies have occurred. One of the uncertainties may be caused by differences in testing environment. Quantachrome NovaWin 1200e was used in 2013 for SSA measurements where the degasser and BET analyser are combined as one machine. The SSA analysis was operated by the IRIS laboratory assistants instead of students that may not focus on consistent environment conditions including the process of handling samples. Since the analysis was automated by the software except for temperature, the hours of degassing were not controlled and the analysis time can reach as high as 69 hours for San Emiliano sample. For the same sample, the degassing time was only 28 hours for the other group of students that gives the SSA result of 5.231m^2/g instead of 8.292m^2/g (Buan and Ringen, 2013; Ruud and Ågotnes, 2013). With all these discrepancies, the reliability of results that were obtained in 2013 are questionable but still should not be totally ignored as the standard procedure for SSA analysis is not defined.

Another possible cause that affected the measurements is the samples. A lot of powdered samples from the same formation were prepared and stored without any further information. This has caused confusion on which powdered samples should be chosen for this SSA analysis and has a high probability where different samples are used. Since it is hard to decide on a particular sample, these samples are mixed in order to average out the inconsistency of a formation.

There could be more unknown factors that contribute to these variations in the result of SSA measurements. These factors are hard to be determined as the elements are not bound where more studies need to be done in the near future to develop a better understanding.

6.1.4 SSA Results between Different Methodologies

Previously an SSA measurement was performed for a section of Liège and Stevns Klint samples with a slight different in methodology instead of a whole cylindrical core. The section was divided into three segments; each segment was analysed four to five times in pellet form and two time in powder form where the same sample from each segment that was tested were reused. During this analysis the same sample was reused in analysis, the sample was exposed to normal environment where the sample will revert back to its original condition before the testing. Approximately twenty analyses were done for a single core section so that the errors

were reduced as much as possible. These measurements were averaged within the same form and compared to the SSA measurements from this study.

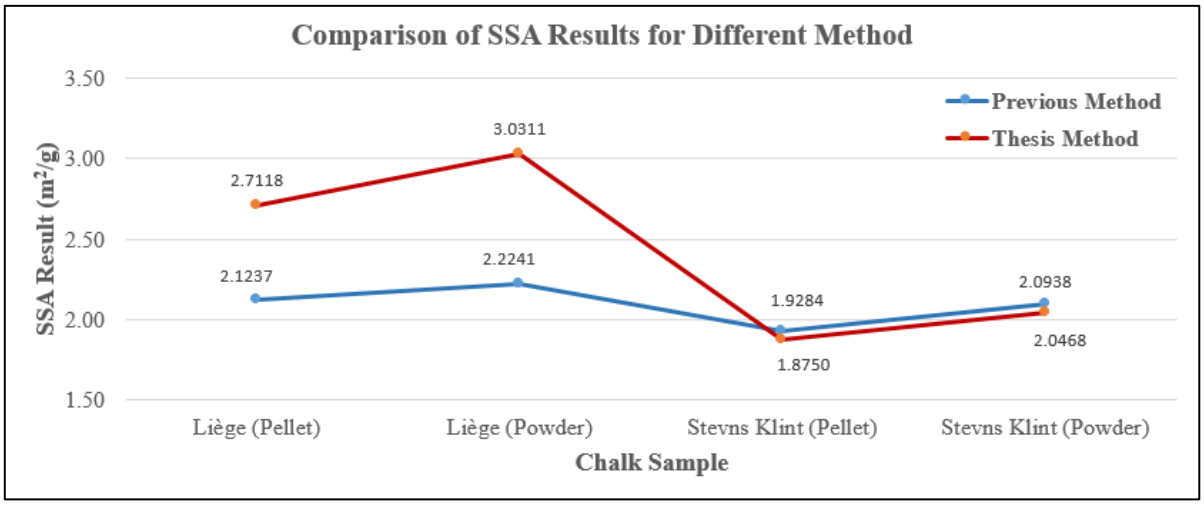


Figure 32: This plot shows a slight variation in SSA result using a different methodology.

Stevns Klint chalk sample shows that there is not much difference in SSA measurements between previous and current method used as the trend line is almost exactly the same though the value is slightly lower in this thesis. For Liège chalk sample on the other hand, the result has higher SSA measurements comparing to the SSA result values obtained from the previous method while still maintaining a similar trend line (Figure 32).

Even though sample from different cores were analysed, the variation of SSA values for Liège chalk samples are considered large as these samples are from the same formation without huge difference in grain size and compaction. However there is no evidence state that the SSA results from either method are invalid.

Overall, the measurements from both methods are reliable because the result's trend does not change from the different SSA result values.

6.1.5 SSA Results between Different Rock Types

As there are several rock types to be compared against each other, the tables created for the results are not able to represent the SSA results differences between all the rock types. It is worth mentioning here that eight rock types are analysed; chalk, sandstone, quartz arenite, shale, limestone/dolomite, tuff, tillite/diamictites, and dacite.

From the radar plot (Figure 34), high abundance of SSA values are focused in the centre of the plot with measurements ranging between $0.0m^2/g$ and $5.0m^2/g$. Chalk samples have measurements concentrated below $5.0m^2/g$ even though thirty three samples are used in the

analysis while ten limestone/dolomite samples have wider variation in range of SSA measurements that reach 24.0m^2/g (Figure 33). Other samples like quartz arenite, sandstone, and tuff also share a similar trait which have a variety of SSA measurements though with smaller variation. The compilation of results show that chalk samples have better consistency of SSA results which indicate there is hardly any major difference in rock characteristic although they came from diverse geological locations.

For rock types that have less than five samples such as quartz arenite, shale, and dacite, it is hard to determine the trustworthiness of SSA measurements in average as there are very few measurements to estimate errors. In contemplation of retrieving unprejudiced comparisons of SSA measurements, the number of samples used in analysis for each rock types from different localities have to be the same. Despite only a few measurements for a particular sample, these valid values are still credible to be taken into account for measurements comparisons.

Another rock type, salt is not included into this plot as there is only one measurement that has very small value which hardly can be identified. It has a SSA measurement of 0.3781m^2/g that lies within the concentrated cluster.

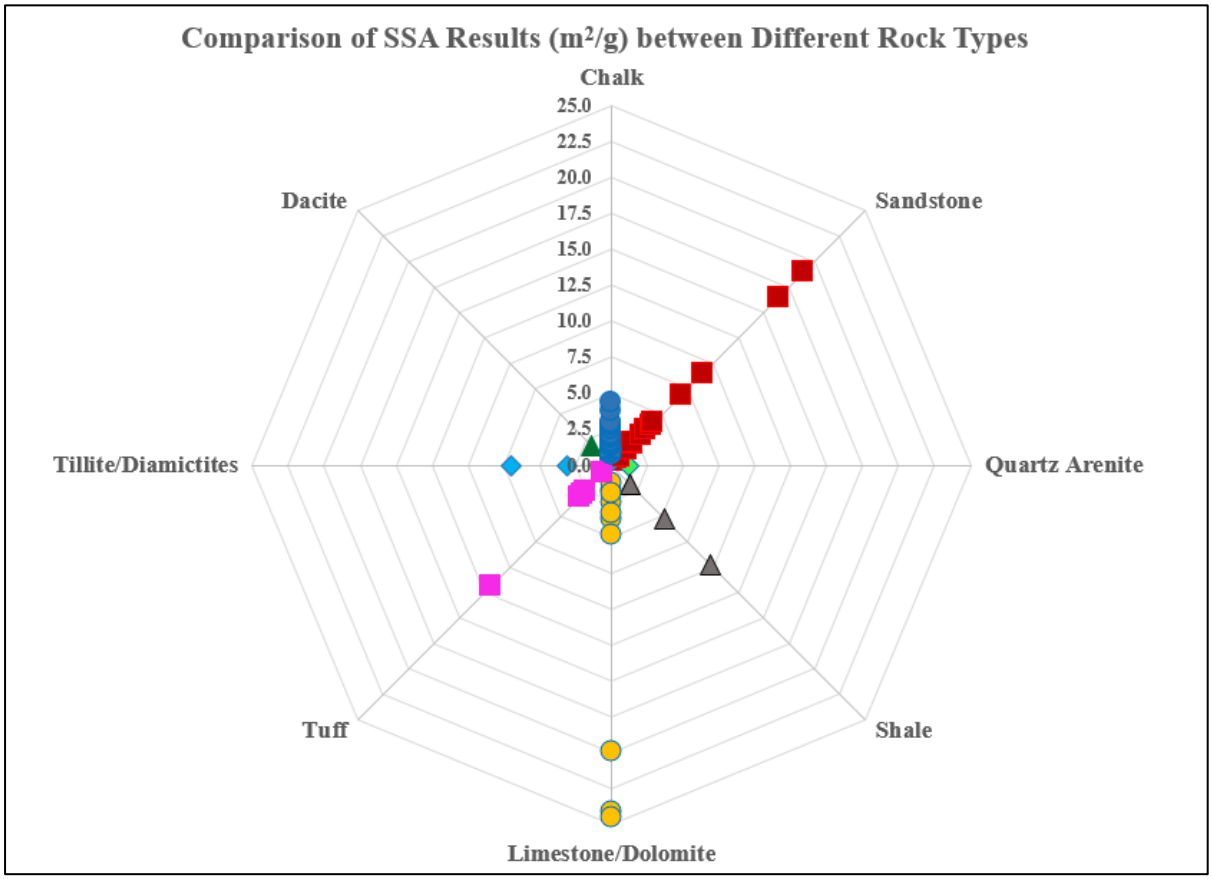


Figure 33: This radar plot (shaped similar to a spider web) can be used to compare SSA measurements between different rock types based on a single variable. Most of the SSA measurements are concentrated in the centre of the plot within the range of 0.0m^2/g and 5.0m^2/g.

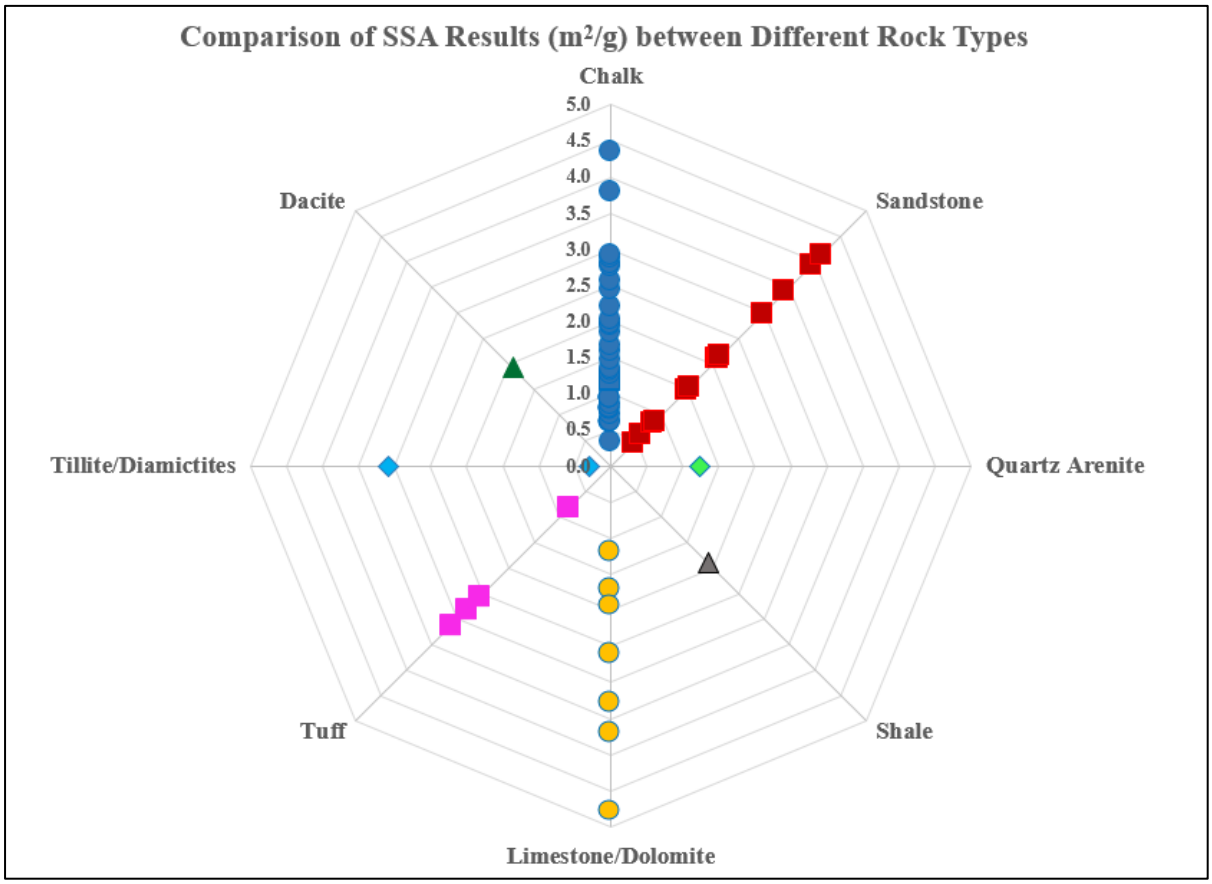


Figure 34: The radar plot shown here is a subset of the previous radar plot in Fig. 33 and is focused between SSA values 0m²/g to 0.5m²/g to enhance any sub-trends which may observe in the data.

Differences of SSA measurements for different rock types are influenced by a lot of parameters which are hard to determine without thorough examinations. One of such examples is sandstone, the second most common sedimentary rock after shale. Sandstone consists of two main components: (i) a framework composed of sand-sized grains (ii) interstitial volume between grains which may or may not filled with chemical cement of silica or calcium carbonate or fine-grained matrix, with quartz, feldspar, and rock fragments as principal mineral constituents. Due to their diverse textures and mineralogy caused by erosional and depositional processes (The Editors of Encyclopedia Britannica, 2018b), diverse SSA results can be obtained as shown in the plot.

The quartz arenite generally has high degree of hardness composed of greater than 90% detrital quartz where silica precipitate from interstitial waters in the subsurface and recrystallize under high temperatures and pressures. It is stated that this rock type is free from pores and have smooth fractures because the grains are broken through when they are pounded (The Editors of Encyclopedia Britannica, 2018a). However, SSA analysis for quartz arenite sample shows that it does have specific surface area of 1.2314m²/g, indicating the existence of porosity.

The previous discussions have expressed that parameters like porosity, grain sizes, sorting, minerals, compaction, and more play an important role in influencing specific surface area of each rock sample. Further academic work needs to be done in order to completely understand how these parameters prompt the behaviours of specific surface area in samples.

6.2 Correlations of Key Parameters

6.2.1 Density versus SSA Result

There are wide ranges of density measurements for all of the different rock types which are affected by atomic concentration in a given volume. To justify the correlation between density and SSA result, a visual aid (plot) is established for an easier illustration. In a glimpse, the values are not organised however certain trends for series of samples can be discovered.

In this plot (Figure 35), chalk samples (blue circles) has a consistency in SSA measurements from 0.0m^2/g to 5.0m^2/g, concentrated below 2.5m^2/g however with broad density values ranges between 1.0g/cm^3 and 3.5g/cm^3. Contrarily, limestone/dolomite samples (yellow circles) show a regularity in density variables between 2.5g/cm^3 and 3.0g/cm^3 with vast differences in SSA measurements up to 25.0m^2/g. On the other hand, there are samples that do not follow any trends, for example tuff samples (magenta square) where the values for density are from 0.5g/cm^3 until 2.5g/cm^3 with SSA values ranges between 0.0m^2/g and 12.5m^2/g.

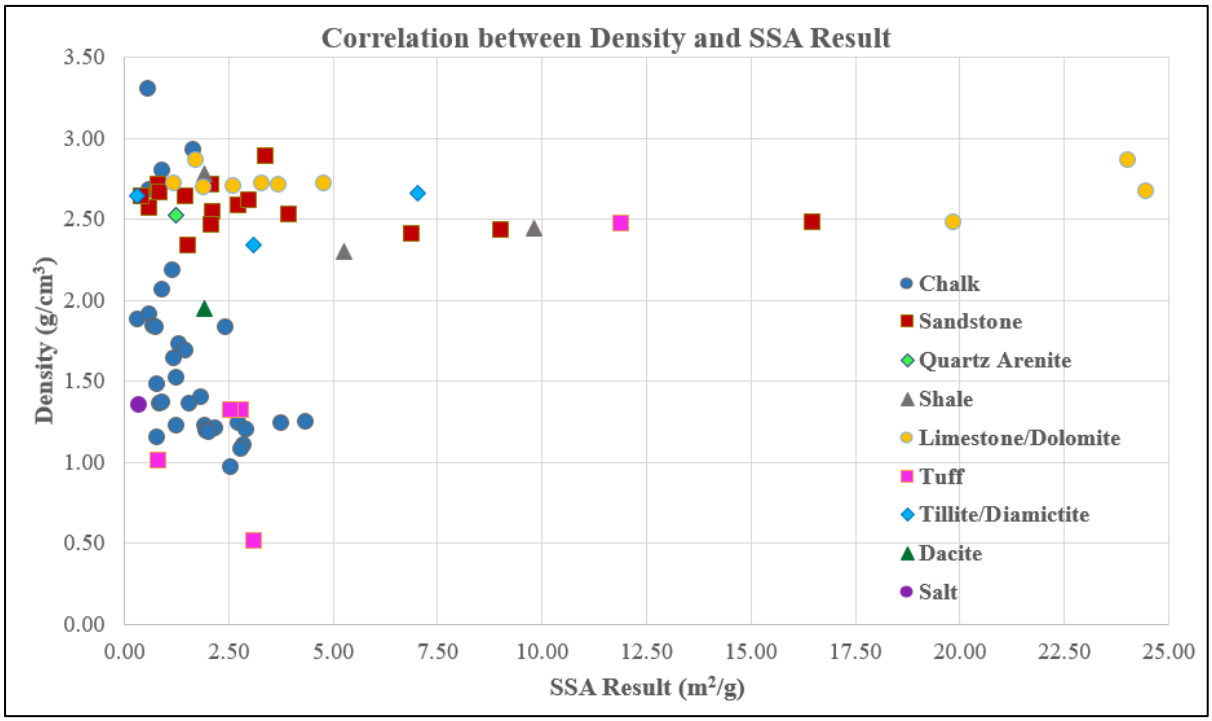


Figure 35: This plot shows the relationship between density and SSA results of samples.

All these results have suggested that density does not have much correlation with SSA measurements because density is caused by mineral compositions and compaction. If a sample has heavy minerals like zircon, garnet or rutile, the rock will have a higher density even though the volume is similar to other samples but this will not influence the specific surface area. However, the shape and grain size of these addition minerals eventually will impact the SSA measurements. Comparing to mineral compositions, compaction does make a difference to specific surface area because compaction will reduce the porosity with increasing density hence a decrease in the SSA measurements.

6.2.2 Grain Size versus SSA Result

Wentworth grain size chart (Figure 36) (Krumbein, 1937) is a scale that classifies and describes sediments with respect to detailed grain sizes (mm) and is divided into categories which is used in this analysis. These samples have distribution of grain sizes from clay until fine pebbles where most of the samples have grain sizes that cross categories.

A bubble plot is used to display the relationship between grain size and SSA result. Since there are a few categories of grain sizes in a sample, it is hard to decide which grain size is to be used and therefore an approximate median is designated for each sample. The sizes of the bubbles are determined by number of categories of grain sizes can be distinguished in the sample. The larger the number categories of grain sizes distinguished in the sample, the bigger the size of the bubble will be. For instance, when a sample has grains with sizes ranging from fine silt until very coarse sand (0.008mm to 2.0mm), a median of approximately 0.125mm grain size is chosen. According to the Wentworth chart, eight categories of grain sizes are observed in that sample, so the size of the bubbles in the plot is set to be ‘8’.

In the correlation plot (Figure 37), the grain size for chalk samples are within the clay categories (less than 0.004mm) with SSA results until 5.0m^2/g. Sandstone samples have wider range of grain sizes that include clay, silt, sand, and fine pebbles. For clayish to silty sandstone, the SSA measurements values range up to 20.0m^2/g; while smaller values around 2.0m^2/g for SSA result is found for larger grain size. Even though limestone/dolomite samples do not have large grain sizes like sandstone, a similar trait is observed. Detailed grain size information for all the samples is recorded in the spreadsheet (Appendix J).

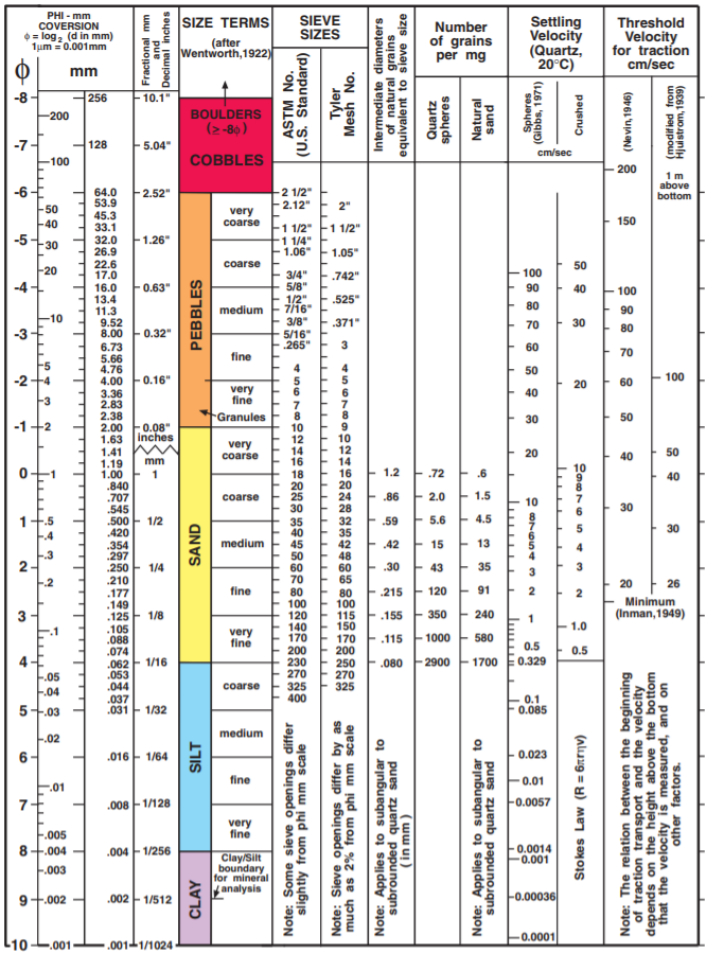


Figure 36: Wentworth Grain Size Chart used in determining samples' grain size (Krumbein, 1937).

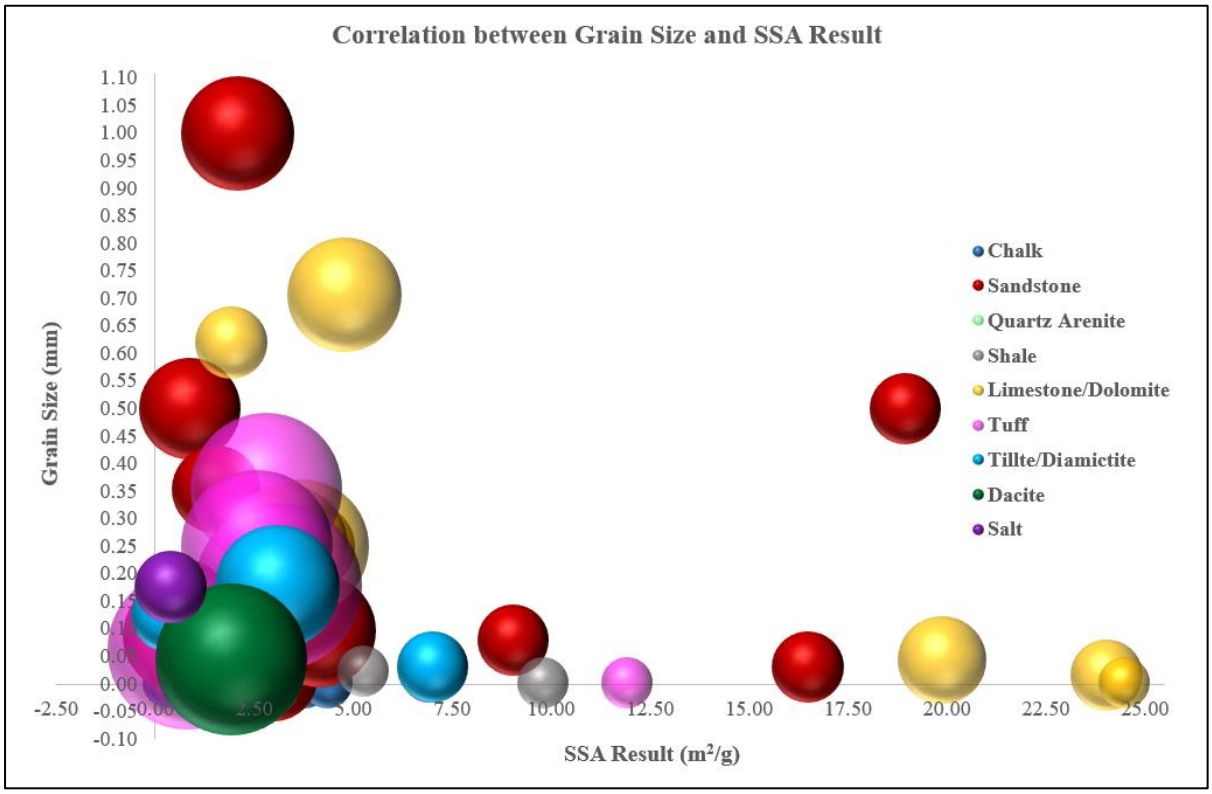


Figure 37: This bubble plot represents the relationship between grain size and SSA results of samples.

André et al. (2009) had developed a model to represent the inverse dependency of specific surface area on the grain size. In conjunction, the results that are obtained and displayed in the bubble plot does not support the model where no clear correlation can be established for the samples. The reason behind this dissimilarity of both plots is due to the error in preparing the sample. For a better understanding about the influence of grain size on SSA measurement, an extra step needs to be performed prior to running the SSA analysis. After the samples are powdered, the powder needs to be sieved into five size fractions: 2.0mm, 1.0mm, 0.5mm, 0.125mm, and 0.071mm. These different size fractions are then analysed separately (André et al., 2009). In this study, the grain size for the samples are only determined visually via microscope which does not give precise grain size distribution as sieved samples, without ignoring that fact that some course grained samples (example conglomerate) may have grains larger than 1 gram.

Another point worth mentioning is that the powdered sample may have been mechanically disturbed. With all these shortcomings added to the analysis, this dependency plot (Figure 37) is not reliable. This plot should be rebuild in the future by avoiding any such discrepancies to establish a reliable relationship between these parameters.

6.2.3 Porosity versus SSA Result

Porosity has always been considered as the main physical property that influences the interstitial surface area of a solid. A few pore types can be identified based on the effectiveness of external fluid flow which mainly is categorised into open and closed pores. A simple schematic cross section of a porous solid is shown in Figure 38.

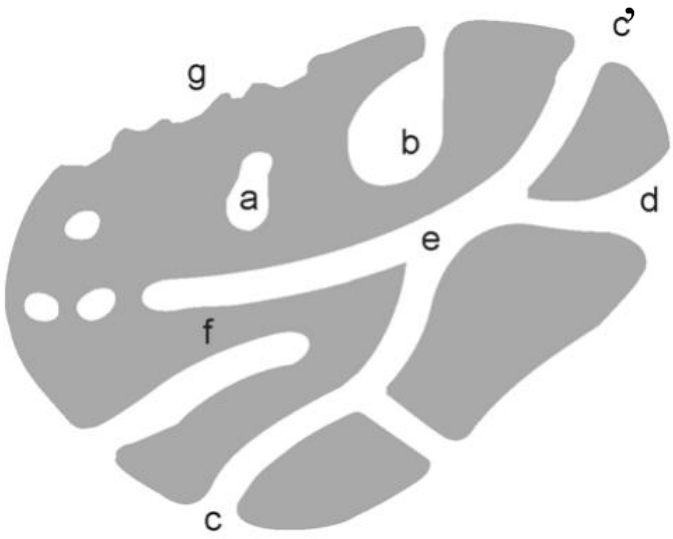


Figure 38: A simple illustration of porosity in a particle with different pore types and shapes (National Institute of Standards and Technology, 2006).

Closed pores (a) are inactive in fluid flow and gas adsorption process which does not add weight in SSA measurement. On the other hand, pores that have navigable channel of connection with external surface known as open pores (b, c, d, e, and f) which further classified into “through pores” and “blind pores”. Through pores allow fluid to re-emerges on the other side of the pore channels (like the pore channels c-e-c’ and c-e-d) while blind pores (b and f), also called as saccate pores only have openings on the surface and close at the other end. Surface roughness (g), is part of a distinct attribute for surface irregularities where they are counted as pores only if they are deeper than they are wide. Both these type of pores play a crucial role in determining specific surface area of a solid where porosity is also influence by their shape. The common shapes include cylindrical (open c and blind f), ink bottle (b), funnel (d) and slit shapes (National Institute of Standards and Technology, 2006).

Porosity evaluation was not done in this study, therefore the porosity values are collected from other studies that were done by other students. However, not all the rock types have porosity data; rock types without porosity data are not added to the plot. All the porosity values are compiled and recorded in the spreadsheet (Appendix J).

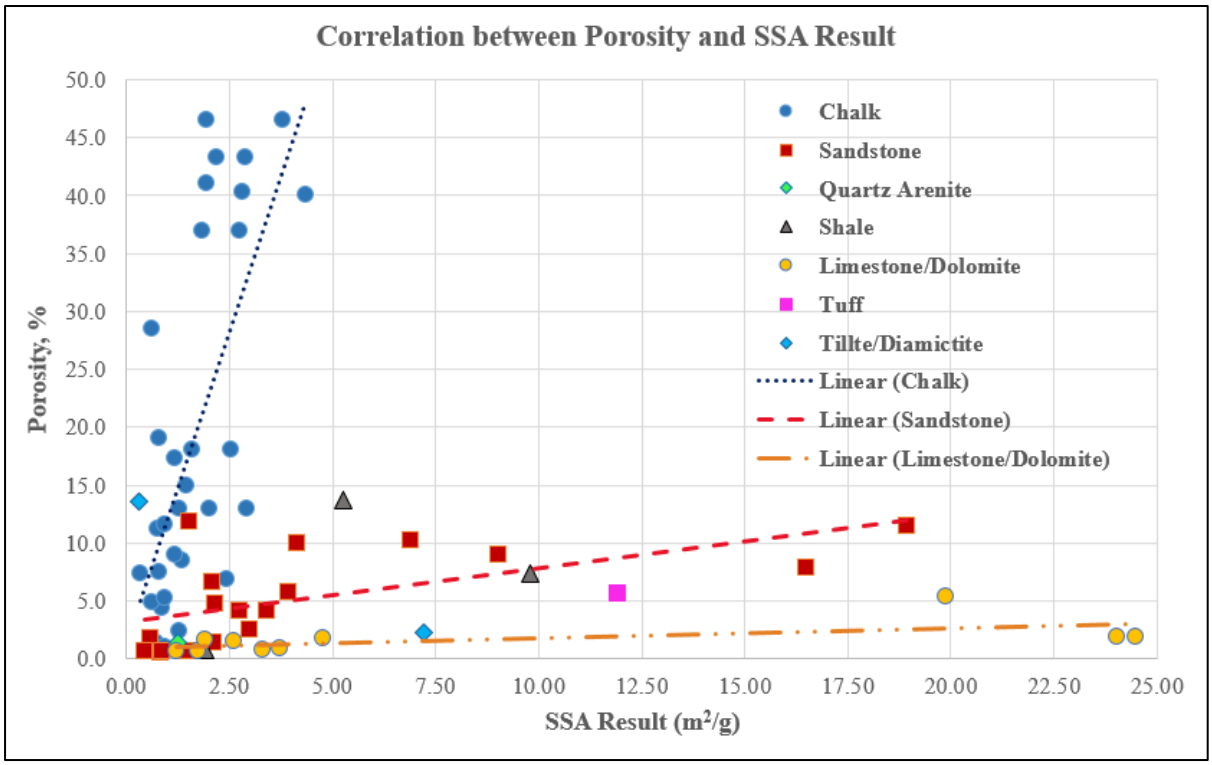


Figure 39: Correlation plot shows the positive relationship between porosity and SSA result.

The correlation plot of porosity and SSA result (Figure 39) has shown the dependency between these two key parameters. For chalk, sandstone, and limestone/dolomite samples, positive linear relationships are identified where the higher the porosity, the higher the SSA result value

is. The trend line slope although different for each sample type, the values for the same sample type following the trend line closely. The relationship between these properties for other sample types are not delineated as number of samples are inadequate to be correlated.

6.3 Permeability

Permeability is the capacity of a rock layer to transmit fluids. Permeability is controlled by four main factors: pore geometry, bedding orientation, porosity, and confining pressure where pore geometry and porosity are the focused factors. In sandstone, permeability is controlled by grain size, grain orientation, packing arrangement, cementation, clay content, bedding, and grain size distribution and sorting. Whereas in carbonates, the degree of mineral alteration, porosity development, and fractures are the influencers on permeability (Ohen and Kersey, 1993).

Generally, permeability has a close relationship with porosity where a bundle of capillary channels in a porous media can influence permeability by the inter-connectivity of pores. Due to the complexity of the porous media's geometry, a better understanding of the rock properties is the key to relating fluid flow properties to reservoir rock properties. Qualitatively, it is assumed that permeability increases with the increase of porosity (Ohen and Kersey, 1993). Nevertheless, even if porosity exists in the rock sample, there is no guarantee on the existence of permeability because closed pores do not permit fluid transmission.

Instead of the Hazen equation and the Krumbein and Monk equation, the Kozeny-Carman equation is effective for a wide variety of soils and sediments (Porter et al., 2012) which is the reason this equation is used in this analysis. All the calculated permeability is compiled (Appendix J; Table 9) with other data such as porosity, density, SSA measurements, grain size, and more in order to provide a full description of all the samples.

Permeability was measured in UiS for Spain samples during a Bachelor thesis in 2013 where Darcy's Law is implemented with the equation as follows:

$$\mathbf{Q = k \times A \times \frac{\Delta h}{L}}$$

Where:

Q : total discharge of fluid per unit time (cm^3/s)

k : permeability constant (measured in millidarcy, mD)

A : cross-sectional area of sample mass

$\boldsymbol{\Delta h}$: difference in total heads

$\boldsymbol{L}$: total length of core sample / flow path (Bengtson, 2011)

Sample	2013 Measurements ($\times 10^{-3}$ mD)	2013 Calculations ($\times 10^{-3}$ mD)	2018 Calculations ($\times 10^{-3}$ mD)
SAL3	5.2000	3.3000	1.2798
HE14	554.0000	228.7000	3.8059
LD	8.2000	0.0135	6.8665
L13	0.4790	0.0119	0.1564
G18	0.0279	0.0881	0.0383
OV7	15.1000	23.0000	3.4889
B4	5.6000	414.6000	1.4441
SP7	1.3000	4.7000	3.6223
LV3	3.0800	9.9400	0.007609
CollaD	0.8600	0.2610	0.1667
SLL	0.3780	0.2696	0.3647
HU7	559000.0000	9.2000	1.4405
Portilla	0.0470	0.0407	0.0251
Gijón	0.1120	0.2720	0.7631
Rodiles	0.0092	0.0405	0.000008101
Vega	57.3000	378.4000	638.2900
VC	43.8000	251.4000	56.1480

Table 9: Table showing all the SSA measurements and calculations from 2013 and 2018.

Table 9 presents a compilation of the measurements and calculations from 2013 which is compared to the calculations performed in this thesis. But sample BT and SE6 are not included in this comparison as no measurement was done for these samples. A comparison plot is not suitable in this scenario because the variations between values are too big to be displayed clearly in a plot.

From the table above, some of the permeability measured values and calculated values are quite comparable for samples G18, SLL, and Portilla which indicate Kozeny-Carman equation is adequate for permeability calculation. However, there are several samples with higher variation of permeability values that are highlighted in yellow in Table 9. The most distinct differences in values can be observed in sample HU7 where the difference is approximately five hundred thousand times which is totally inadmissible. This deviation is caused by using a different equation, tortuosity value and some (unknown) uncertainties. The most probable cause would be the heterogeneity of the rock sample, as in the Huergas Formation fine silt to medium sand is a common grain size variation, but there are also layers with a high amount of fossils which would lead to a higher porosity.

From the equations, Darcy's Law does not take particle size and porosity into consideration while Kozeny-Carman equation does not need input of sample mass (length and diameter of

core) and sample fractures. Since the values of permeability are obtained from different equations, this can cause a huge deviation in permeability measurements such as sample HU7. In addition, tortuosity that is discussed in the methodology chapter is ignored during calculation and can result in a divergence of permeability values because each rock type has its own pore space geometry.

A possible uncertainty which may cause this deviation is different samples are used in this thesis. Different samples give different permeability values, which is why the measured permeability from 2013 should not be use as comparison to the calculated values in this study.

Chapter 7: Conclusion

Specific surface area measurements for samples can vary even though the exact same samples are analysed under consistent conditions. This is due to indisputable errors that occur which can only be reduced by averaging out numerous SSA results for a sample. Despite the indisputable errors, certain key parameters in a sample such as porosity, density, and grain sizes are dependent and related with each other which influence the variation of SSA measurements. Since SSA analysis is very detailed with respect to particle size, a slight difference in any of the influential parameters can have a huge impact to its measurement.

Keeping in mind the findings from this thesis, chalk samples which is the focused reservoir rock type has shown a better consistency of SSA results but there are still a few anomalous measurements. As for other rock sample types, the diverse SSA measurements shows the influencing key parameters are too disparate to be determined. Especially samples like sandstone and limestone/dolomite which are some of the common reservoir rock types, the SSA measurements show a high variation for certain formations and vice versa.

The correlation plot of porosity versus SSA result is best to show that rock porosities have influences towards SSA measurements which support the statement about positive relationship between these parameters. Another correlation plot of grain size versus SSA results which is also reliable to show the definite relationship and a similar trend like “porosity vs SSA result” plot however does not correlate accordingly. The primary reason for the lack of clear correlation is that the assortment of grain sizes from the same sample are not measured as individual grain size classes which caused the irregularity in measurements. In addition, the permeability of the samples that are calculated based on these parameters using the Kozeny-Carman equation shows that a slight difference in either parameters can cause huge deviations.

It can be concluded that SSA measurement can be altered by minor changes to key parameters while it can also be influenced other less obvious parameters in a sample. Further investigation should be done focusing on specific parameters to better understand and resolve the remaining uncertainties and unanswered doubts.

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Appendix

A. BET Report for Chalk Pellet

Aalborg

Sample: A1_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\A1_Pellet.SMP

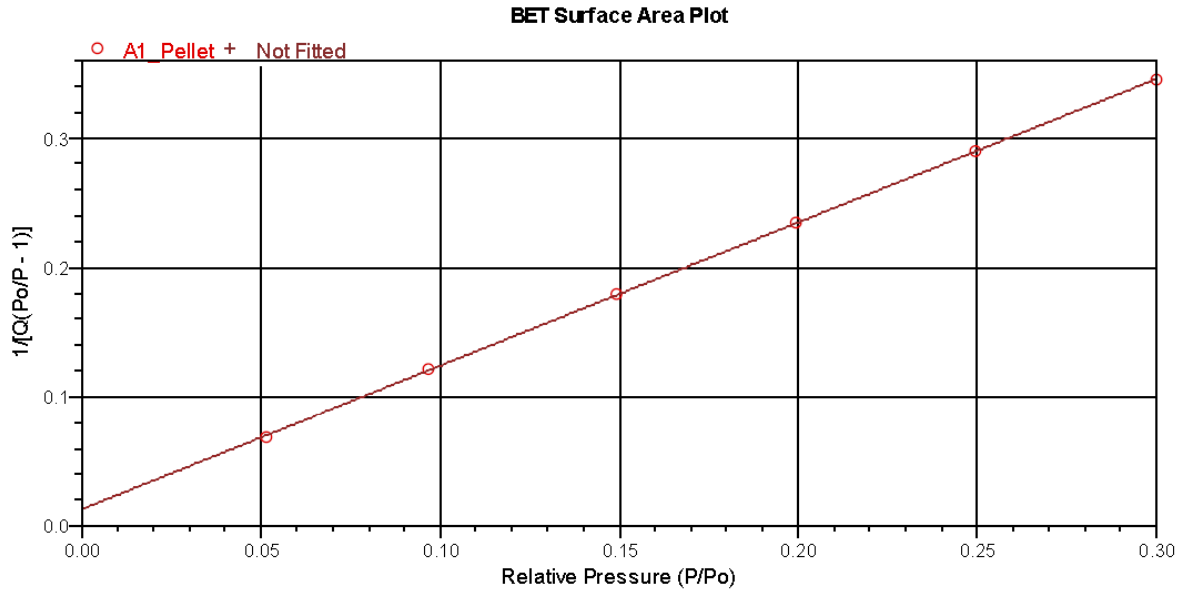
Started: 24.01.2018 15:25:28
Completed: 24.01.2018 16:46:18
Report Time: 24.01.2018 16:47:29
Sample Mass: 2,0409 g
Cold Free Space: 27,4394 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3775 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.8795 ± 0.0114 m²/g
Slope: 1.109105 ± 0.003233 g/cm³ STP
Y-Intercept: 0.012849 ± 0.000628 g/cm³ STP
C: 87.315955
Qm: 0,8913 cm³/g STP
Correlation Coefficient: 0.9999830
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.051602190	0.7860	0.069226
0.096992865	0.8868	0.121123
0.149392953	0.9802	0.179182
0.199506804	1.0647	0.234093
0.249656360	1.1501	0.289299
0.299879269	1.2399	0.345441



Sample: A2_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\A2_Pellet.SMP

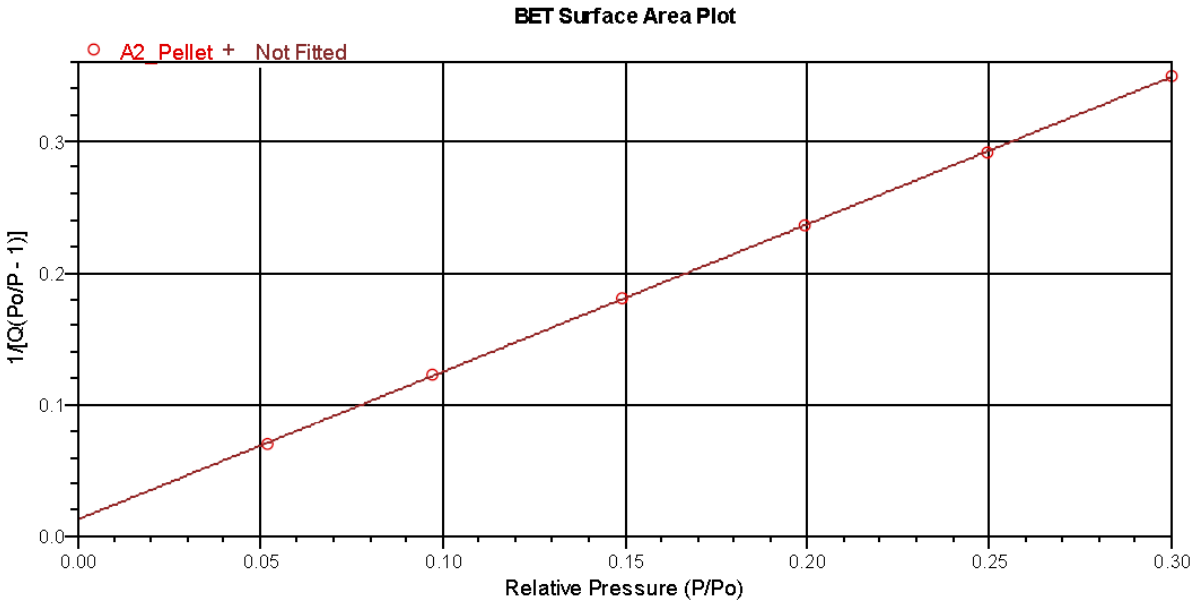
Started: 25.01.2018 15:16:51
Completed: 25.01.2018 16:39:08
Report Time: 25.01.2018 16:39:22
Sample Mass: 2,0109 g
Cold Free Space: 27,2023 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,4166 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.8432 ± 0.0105 m²/g
Slope: 1.119752 ± 0.003049 g/cm³ STP
Y-Intercept: 0.012786 ± 0.000593 g/cm³ STP
C: 88.576807
Qm: 0,8830 cm³/g STP
Correlation Coefficient: 0.9999852
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.052159856	0.7817	0.070402
0.097175065	0.8802	0.122285
0.149451523	0.9724	0.180695
0.199560966	1.0555	0.236194
0.249673114	1.1399	0.291904
0.299930847	1.2287	0.348681



Sample: A3_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\A3_Pellet.SMP

Started: 25.01.2018 15:16:51
Completed: 25.01.2018 16:39:08
Report Time: 25.01.2018 16:39:33
Sample Mass: 2,0321 g
Cold Free Space: 27,3287 cm³
Low Pressure Dose: None
Automatic Degas: No

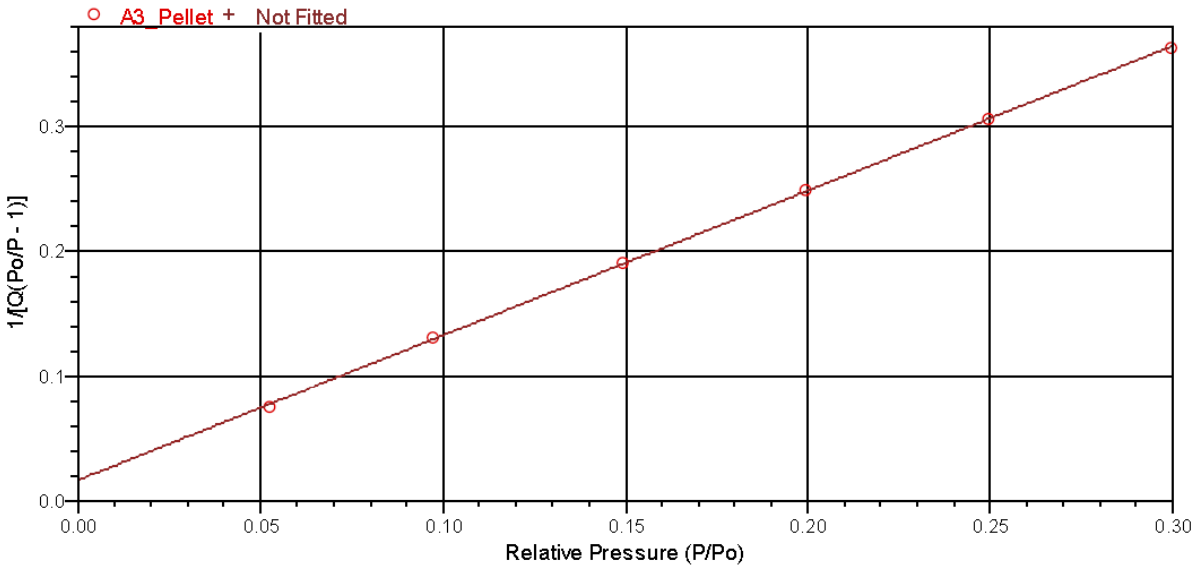
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3693 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.7005 ± 0.0185 m²/g
Slope: 1.159496 ± 0.005759 g/cm³ STP
Y-Intercept: 0.016717 ± 0.001119 g/cm³ STP
C: 70.358967
Qm: 0,8502 cm³/g STP
Correlation Coefficient: 0.9999507
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.052526480	0.7294	0.076003
0.097155355	0.8260	0.130284
0.149309769	0.9186	0.191068
0.199440654	1.0027	0.248466
0.249534700	1.0878	0.305659
0.299733642	1.1771	0.363629

BET Surface Area Plot



Sample: A4_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\A4_Pellet.SMP

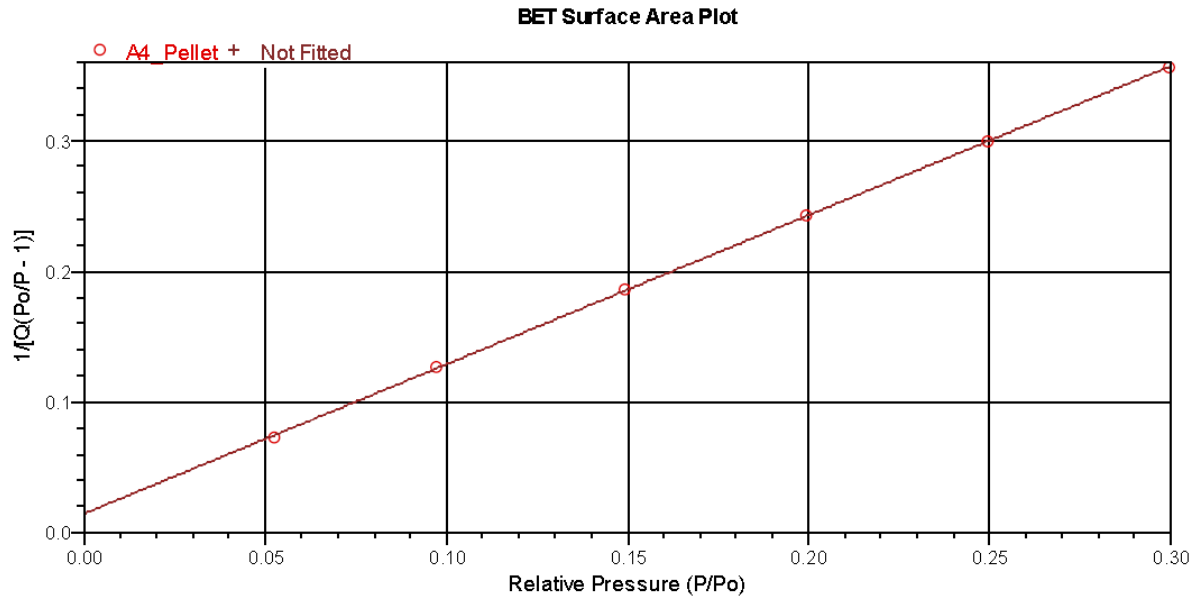
Started: 26.01.2018 15:25:10
Completed: 26.01.2018 16:47:59
Report Time: 26.01.2018 16:49:29
Sample Mass: 1,9984 g
Cold Free Space: 26,6122 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,1841 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.7649 ± 0.0139 m²/g
Slope: 1.141527 ± 0.004196 g/cm³ STP
Y-Intercept: 0.014556 ± 0.000815 g/cm³ STP
C: 79.420704
Qm: 0,8650 cm³/g STP
Correlation Coefficient: 0.9999730
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.052466732	0.7557	0.073273
0.097191741	0.8526	0.126273
0.149346454	0.9443	0.185926
0.199518853	1.0277	0.242530
0.249579642	1.1121	0.299054
0.299725406	1.2009	0.356408



Sample: A5_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\A5_Pellet.SMP

Started: 26.01.2018 15:25:10
Completed: 26.01.2018 16:47:59
Report Time: 26.01.2018 16:49:44
Sample Mass: 2,0501 g
Cold Free Space: 26,3426 cm³
Low Pressure Dose: None
Automatic Degas: No

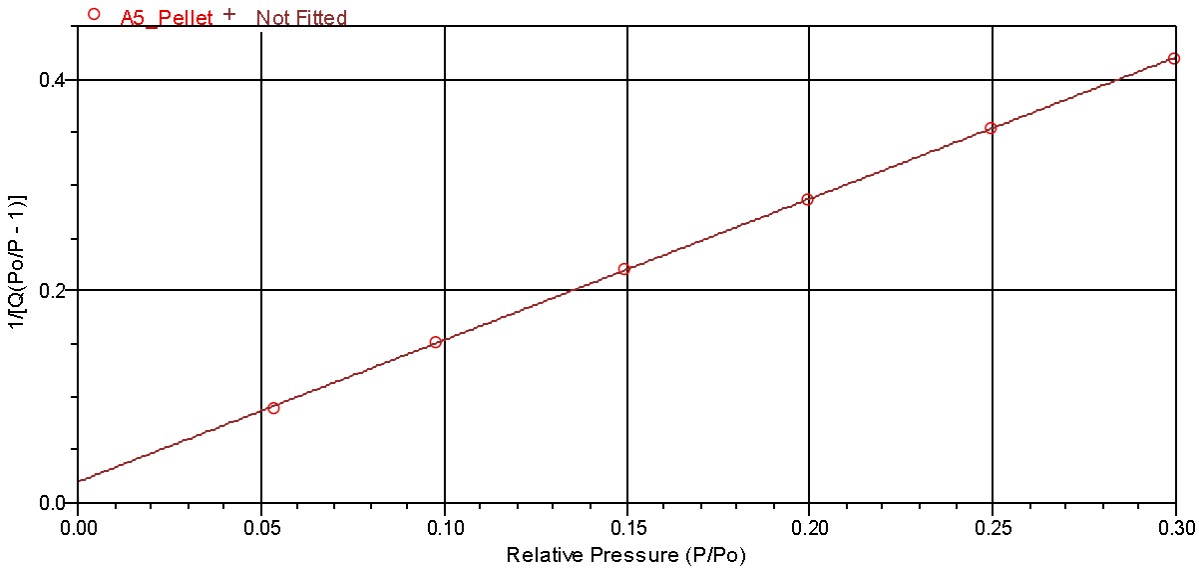
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2939 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.2084 ± 0.0163 m²/g
Slope: 1.336754 ± 0.006777 g/cm³ STP
Y-Intercept: 0.019865 ± 0.001317 g/cm³ STP
C: 68.292029
Qm: 0,7371 cm³/g STP
Correlation Coefficient: 0.9999486
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.053649594	0.6321	0.089690
0.097523933	0.7146	0.151219
0.149423265	0.7947	0.221060
0.199522402	0.8678	0.287221
0.249640622	0.9419	0.353230
0.299676931	1.0198	0.419609

BET Surface Area Plot



Kansas

Sample: K1_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\K1_Pellet.SMP

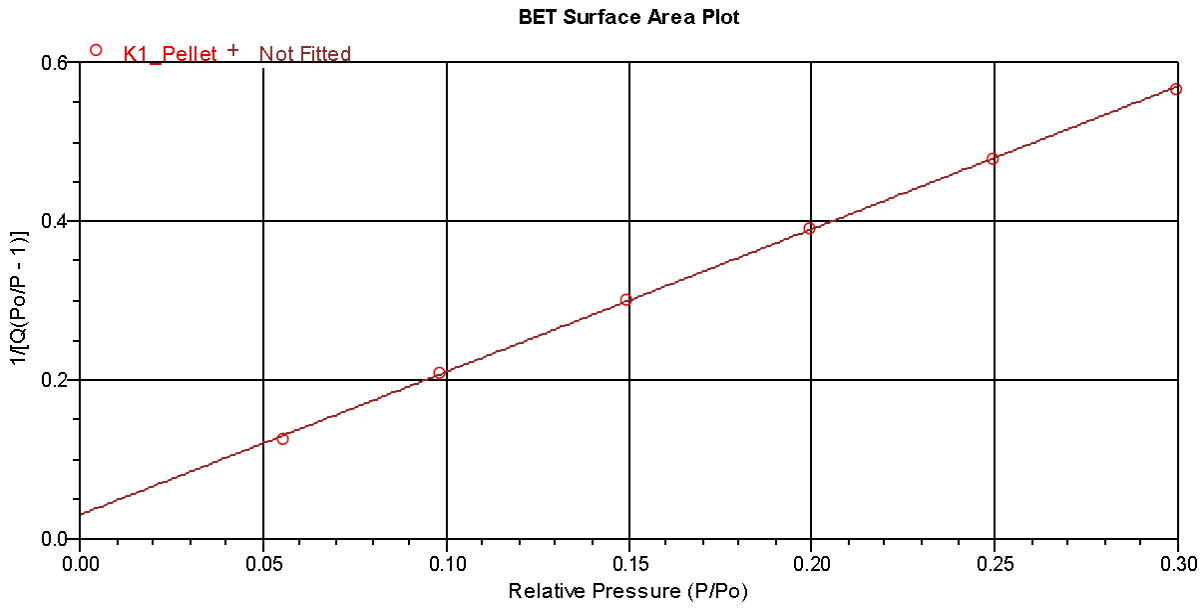
Started: 25.01.2018 15:16:51
Completed: 25.01.2018 16:39:07
Report Time: 25.01.2018 16:39:43
Sample Mass: 2,0775 g
Cold Free Space: 26,8273 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2231 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.3790 ± 0.0202 m²/g
Slope: 1.799475 ± 0.015274 g/cm³ STP
Y-Intercept: 0.030133 ± 0.002970 g/cm³ STP
C: 60.718739
Qm: 0,5466 cm³/g STP
Correlation Coefficient: 0.9998559
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055230044	0.4655	0.125574
0.098189791	0.5230	0.208180
0.149454273	0.5815	0.302151
0.199489063	0.6366	0.391460
0.249485808	0.6941	0.478928
0.299528625	0.7549	0.566429



Sample: K2_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\K2_Pellet.SMP

Started: 24.01.2018 13:47:36
Completed: 24.01.2018 15:06:13
Report Time: 24.01.2018 15:09:20
Sample Mass: 2,0726 g
Cold Free Space: 27,0960 cm³
Low Pressure Dose: None
Automatic Degas: No

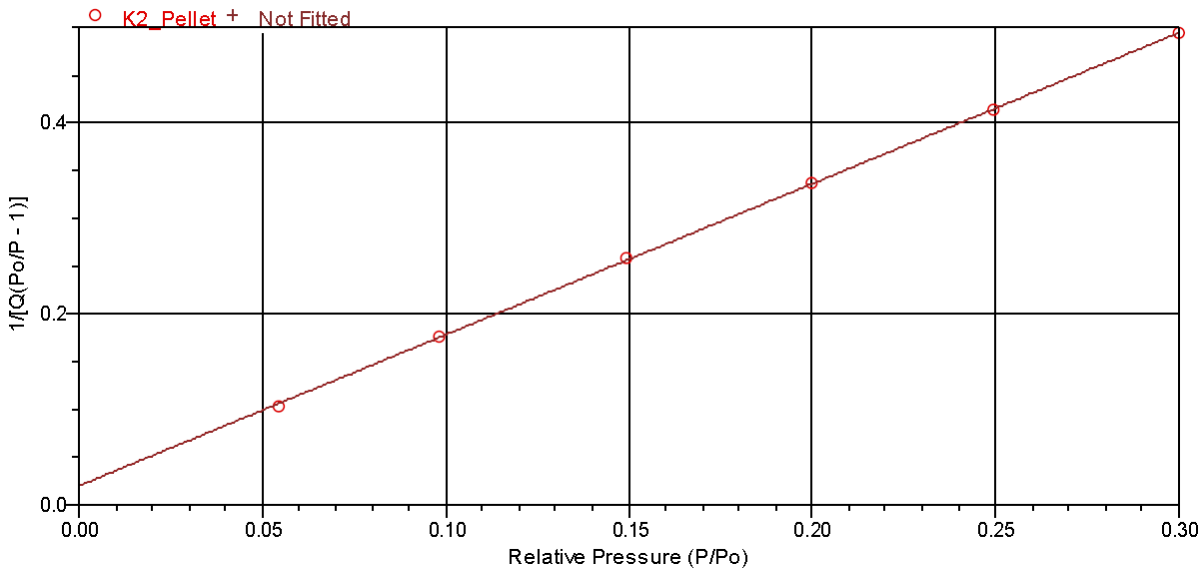
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3266 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.7169 ± 0.0121 m²/g
Slope: 1.582259 ± 0.006975 g/cm³ STP
Y-Intercept: 0.019784 ± 0.001357 g/cm³ STP
C: 80.976599
Qm: 0,6242 cm³/g STP
Correlation Coefficient: 0.9999611
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054274396	0.5532	0.103733
0.098101132	0.6179	0.176032
0.149497931	0.6816	0.257902
0.199598657	0.7418	0.336168
0.249637364	0.8032	0.414229
0.299817177	0.8677	0.493477

BET Surface Area Plot



Sample: K3_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\K3_Pellet.SMP

Started: 24.01.2018 13:47:36
Completed: 24.01.2018 15:06:13
Report Time: 24.01.2018 15:09:31
Sample Mass: 2,1332 g
Cold Free Space: 27,2159 cm³
Low Pressure Dose: None
Automatic Degas: No

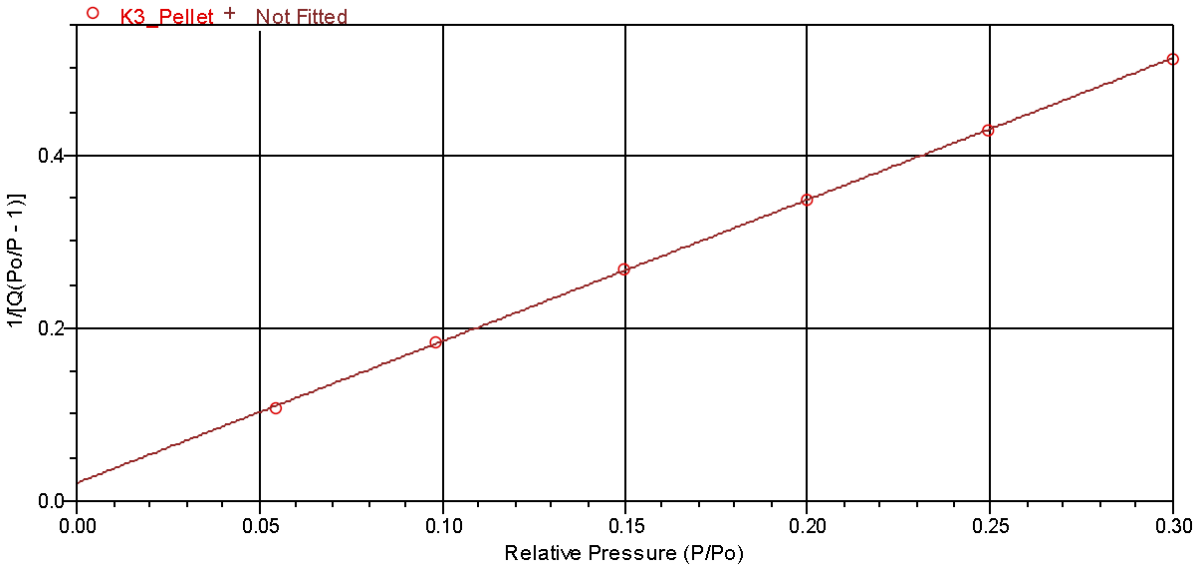
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3245 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.6241 ± 0.0111 m²/g
Slope: 1.637968 ± 0.006899 g/cm³ STP
Y-Intercept: 0.020741 ± 0.001342 g/cm³ STP
C: 79.971353
Qm: 0,6029 cm³/g STP
Correlation Coefficient: 0.9999645
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054313712	0.5329	0.107772
0.098039531	0.5958	0.182430
0.149526478	0.6581	0.267146
0.199602036	0.7162	0.348213
0.249648309	0.7752	0.429174
0.299766237	0.8377	0.511047

BET Surface Area Plot



Sample: K4_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\K4_Pellet.SMP

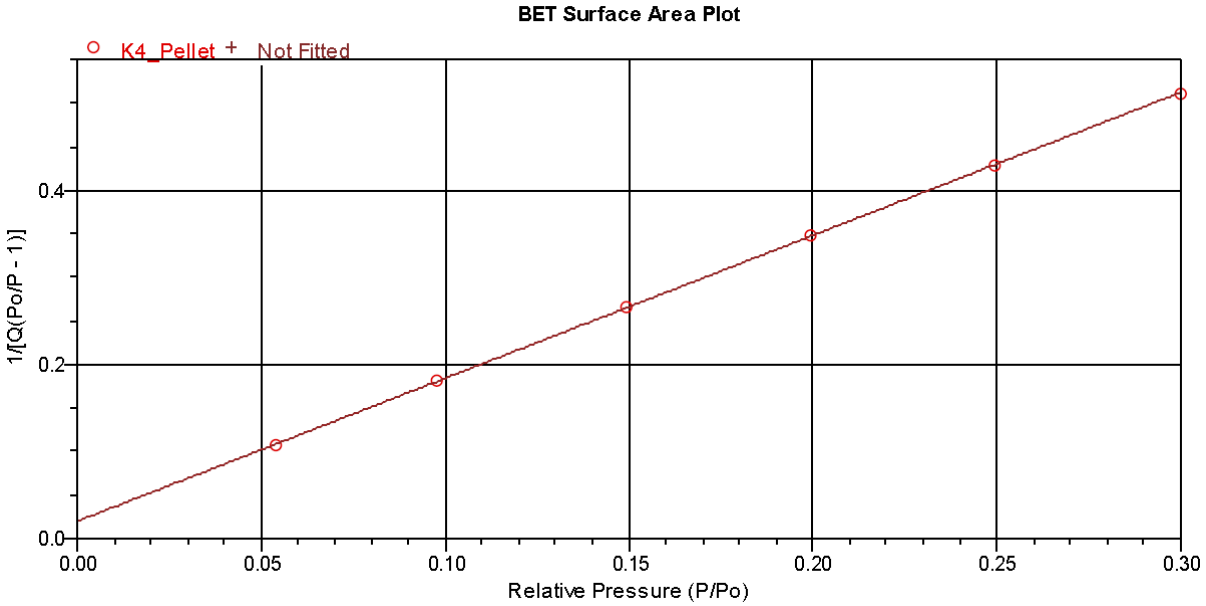
Started: 24.01.2018 15:25:28
Completed: 24.01.2018 16:46:18
Report Time: 24.01.2018 16:47:44
Sample Mass: 2,1237 g
Cold Free Space: 26,7903 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2599 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.6183 ± 0.0091 m²/g
Slope: 1.642662 ± 0.005649 g/cm³ STP
Y-Intercept: 0.019707 ± 0.001098 g/cm³ STP
C: 84.355015
Qm: 0,6016 cm³/g STP
Correlation Coefficient: 0.9999763
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054085485	0.5344	0.106994
0.097955510	0.5978	0.181661
0.149466048	0.6596	0.266427
0.199557478	0.7169	0.347741
0.249609030	0.7752	0.429101
0.299794658	0.8364	0.511882



Sample: K5_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\K5_Pellet.SMP

Started: 24.01.2018 15:25:28
Completed: 24.01.2018 16:46:18
Report Time: 24.01.2018 16:47:59
Sample Mass: 2,0442 g
Cold Free Space: 26,0384 cm³
Low Pressure Dose: None
Automatic Degas: No

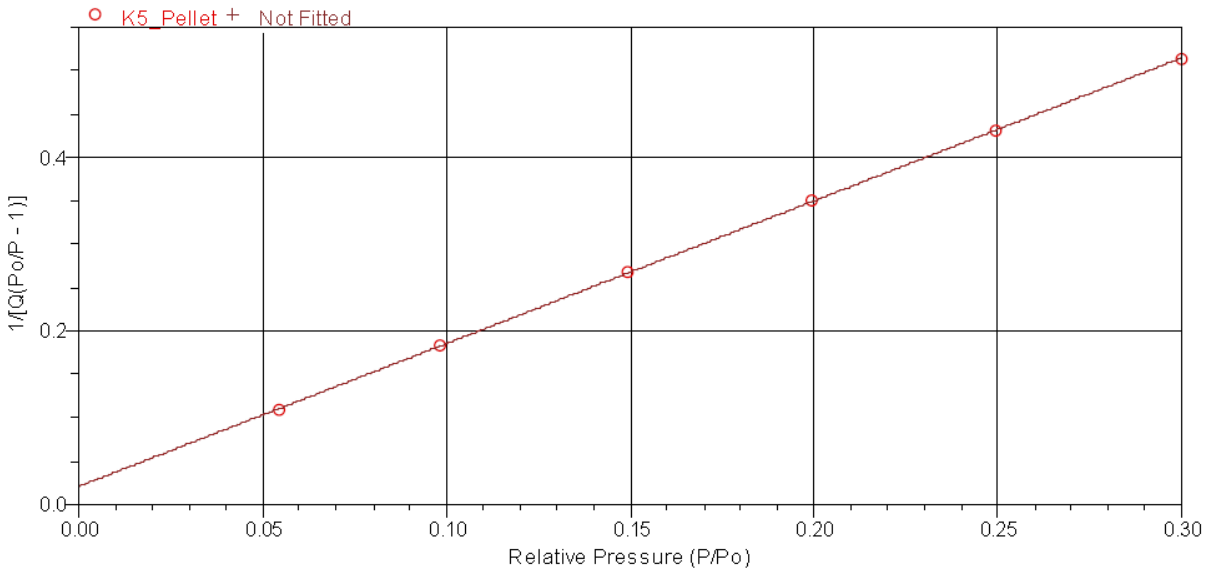
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,0256 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.6147 ± 0.0120 m²/g
Slope: 1.643533 ± 0.007524 g/cm³ STP
Y-Intercept: 0.021144 ± 0.001463 g/cm³ STP
C: 78.730711
Qm: 0,6007 cm³/g STP
Correlation Coefficient: 0.9999581
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054505611	0.5306	0.108642
0.098115229	0.5929	0.183475
0.149466435	0.6547	0.268437
0.199566712	0.7126	0.349863
0.249616360	0.7720	0.430901
0.299781642	0.8346	0.512985

BET Surface Area Plot



Liège

Sample: L1_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\L1_Pellet.SMP

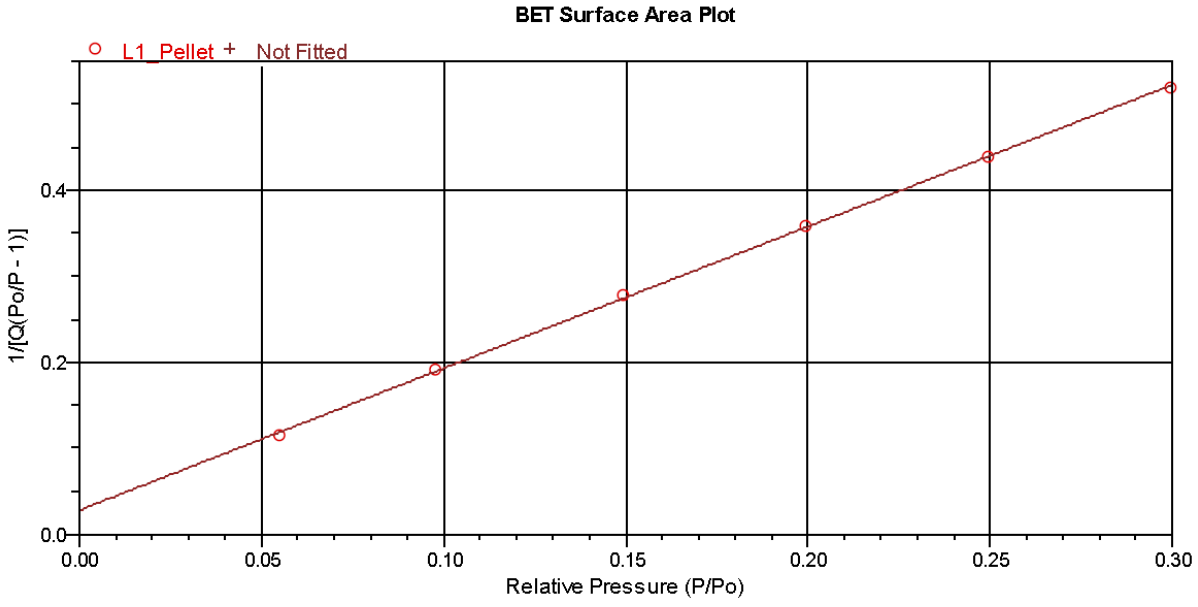
Started: 31.01.2018 15:53:19
Completed: 31.01.2018 17:10:23
Report Time: 31.01.2018 17:11:37
Sample Mass: 2,0660 g
Cold Free Space: 26,8002 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2241 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.5984 ± 0.0218 m²/g
Slope: 1.646852 ± 0.013786 g/cm³ STP
Y-Intercept: 0.028265 ± 0.002679 g/cm³ STP
C: 59.264529
Qm: 0,5970 cm³/g STP
Correlation Coefficient: 0.9998599
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054706414	0.5041	0.114798
0.097899933	0.5691	0.190701
0.149413096	0.6337	0.277183
0.199410865	0.6944	0.358713
0.249406677	0.7571	0.438888
0.299467049	0.8237	0.519004



Sample: L2_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\L2_Pellet.SMP

Started: 31.01.2018 15:53:19
Completed: 31.01.2018 17:10:24
Report Time: 31.01.2018 17:11:17
Sample Mass: 2,1077 g
Cold Free Space: 26,0911 cm³
Low Pressure Dose: None
Automatic Degas: No

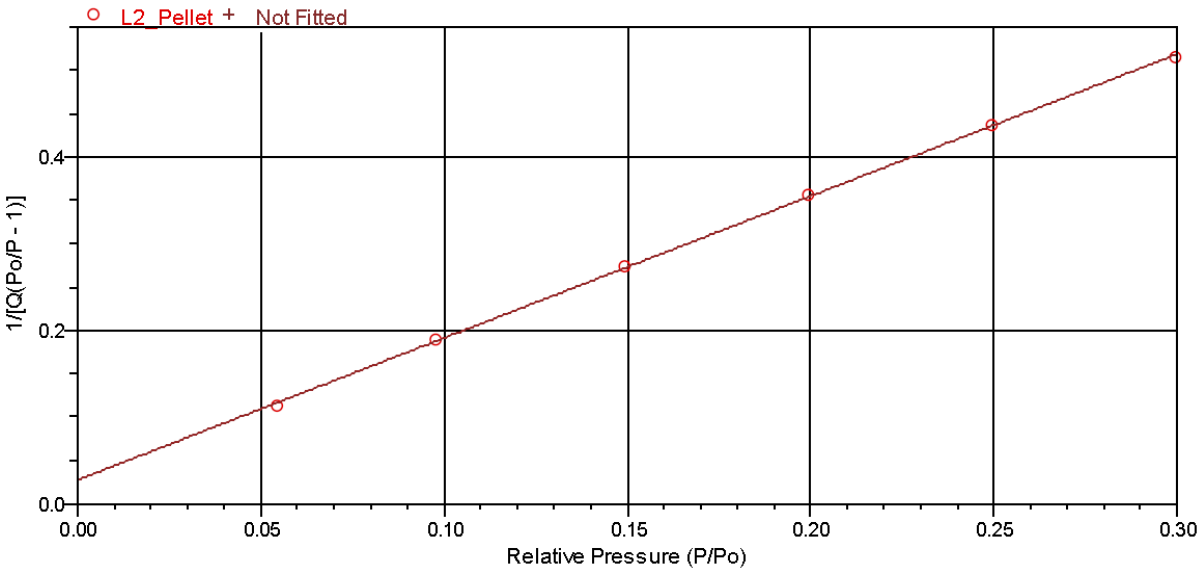
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,0667 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.6157 ± 0.0210 m²/g
Slope: 1.636444 ± 0.013139 g/cm³ STP
Y-Intercept: 0.027599 ± 0.002554 g/cm³ STP
C: 60.293769
Qm: 0,6009 cm³/g STP
Correlation Coefficient: 0.9998711
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054617630	0.5087	0.113567
0.097837375	0.5741	0.188903
0.149407503	0.6393	0.274776
0.199493317	0.7000	0.355989
0.249429669	0.7627	0.435732
0.299579148	0.8297	0.515488

BET Surface Area Plot



Sample: L3_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\L3_Pellet.SMP

Started: 31.01.2018 15:53:19
Completed: 31.01.2018 17:10:24
Report Time: 31.01.2018 17:11:26
Sample Mass: 2,0438 g
Cold Free Space: 27,4880 cm³
Low Pressure Dose: None
Automatic Degas: No

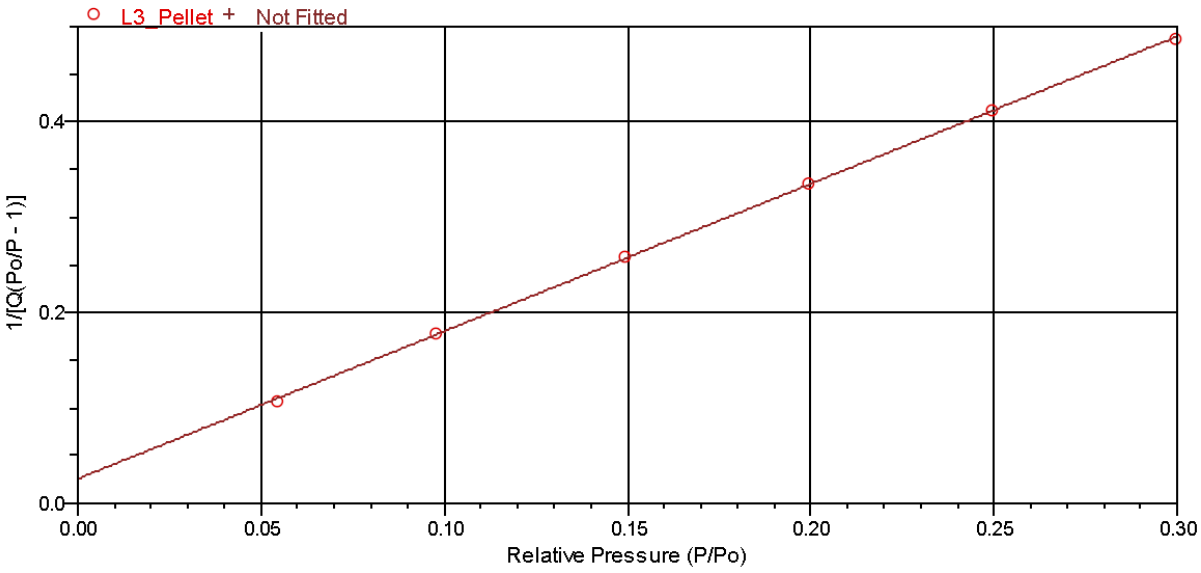
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3821 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.7667 ± 0.0218 m²/g
Slope: 1.547855 ± 0.012173 g/cm³ STP
Y-Intercept: 0.025323 ± 0.002366 g/cm³ STP
C: 62.125382
Qm: 0,6357 cm³/g STP
Correlation Coefficient: 0.9998763
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054571314	0.5413	0.106627
0.097919092	0.6098	0.178007
0.149391303	0.6779	0.259059
0.199511938	0.7420	0.335905
0.249461882	0.8079	0.411397
0.299527320	0.8784	0.486781

BET Surface Area Plot



Sample: L4_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\L4_Pellet.SMP

Started: 01.02.2018 14:12:50
Completed: 01.02.2018 15:32:55
Report Time: 01.02.2018 15:33:11
Sample Mass: 1,9971 g
Cold Free Space: 27,2441 cm³
Low Pressure Dose: None
Automatic Degas: No

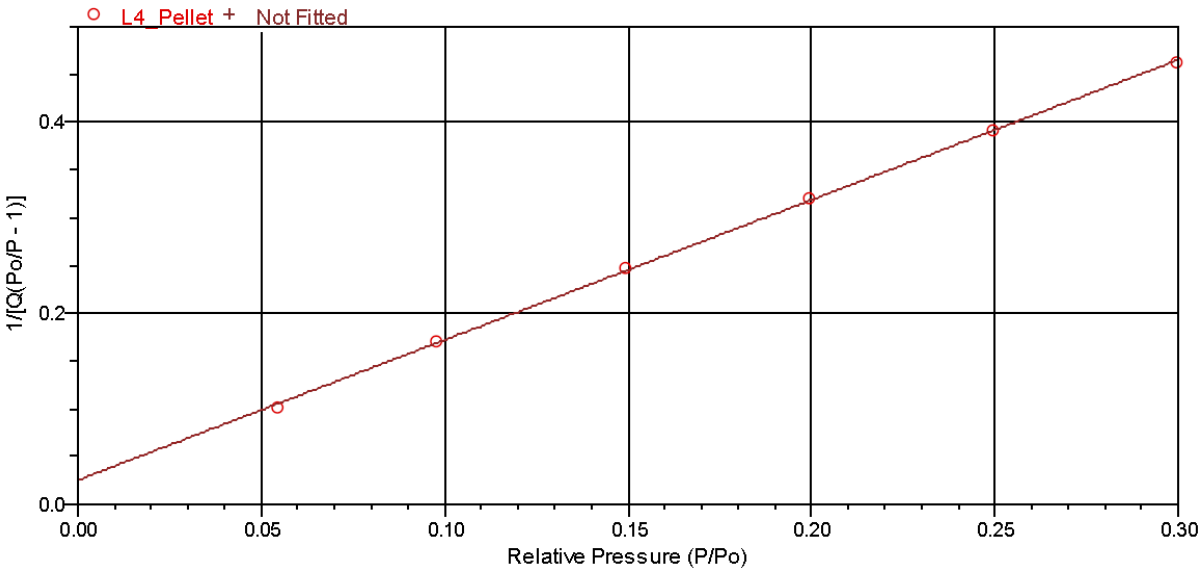
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3655 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.9163 ± 0.0247 m²/g
Slope: 1.467503 ± 0.012389 g/cm³ STP
Y-Intercept: 0.025013 ± 0.002407 g/cm³ STP
C: 59.669164
Qm: 0,6700 cm³/g STP
Correlation Coefficient: 0.9998575
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054394194	0.5660	0.101632
0.097785198	0.6390	0.169602
0.149387788	0.7115	0.246846
0.199414605	0.7797	0.319456
0.249372994	0.8500	0.390862
0.299475456	0.9247	0.462311

BET Surface Area Plot



Sample: L5_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\L5_Pellet.SMP

Started: 02.02.2018 13:37:29
Completed: 02.02.2018 14:58:16
Report Time: 02.02.2018 14:58:48
Sample Mass: 2,0672 g
Cold Free Space: 26,8739 cm³
Low Pressure Dose: None
Automatic Degas: No

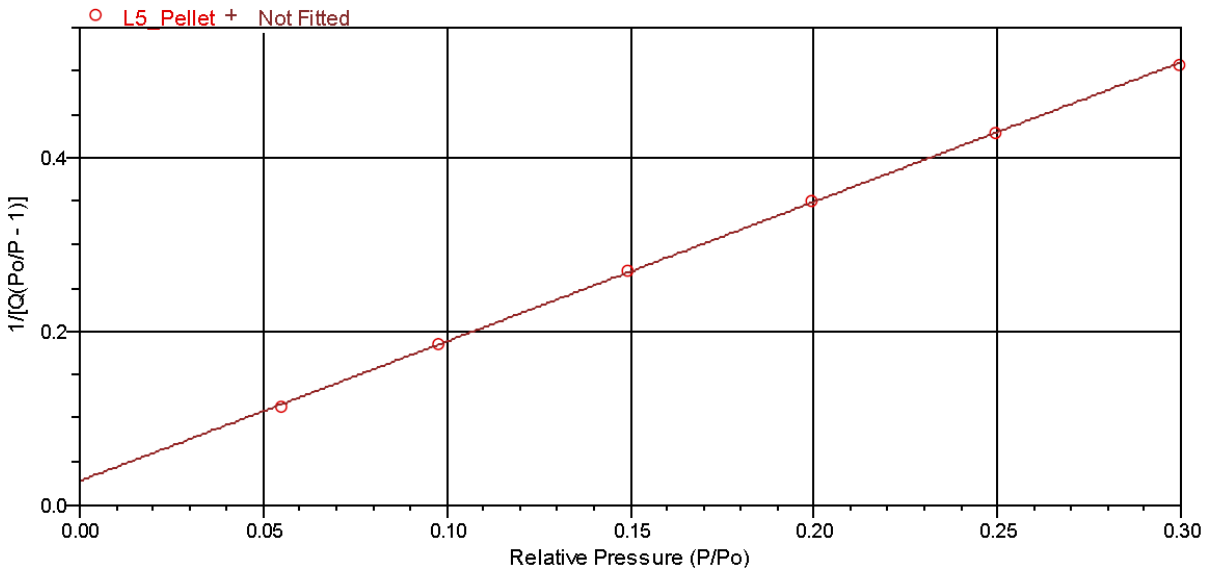
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2491 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.6618 ± 0.0224 m²/g
Slope: 1.607435 ± 0.013534 g/cm³ STP
Y-Intercept: 0.027752 ± 0.002631 g/cm³ STP
C: 58.922371
Qm: 0,6116 cm³/g STP
Correlation Coefficient: 0.9998582
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054849464	0.5162	0.112431
0.097947289	0.5826	0.186369
0.149467312	0.6490	0.270790
0.199508913	0.7111	0.350480
0.249491007	0.7754	0.428720
0.299546179	0.8438	0.506828

BET Surface Area Plot



Mons, limit Obourg Nouvelles

Sample: MON1_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MON1_Pellet.SMP

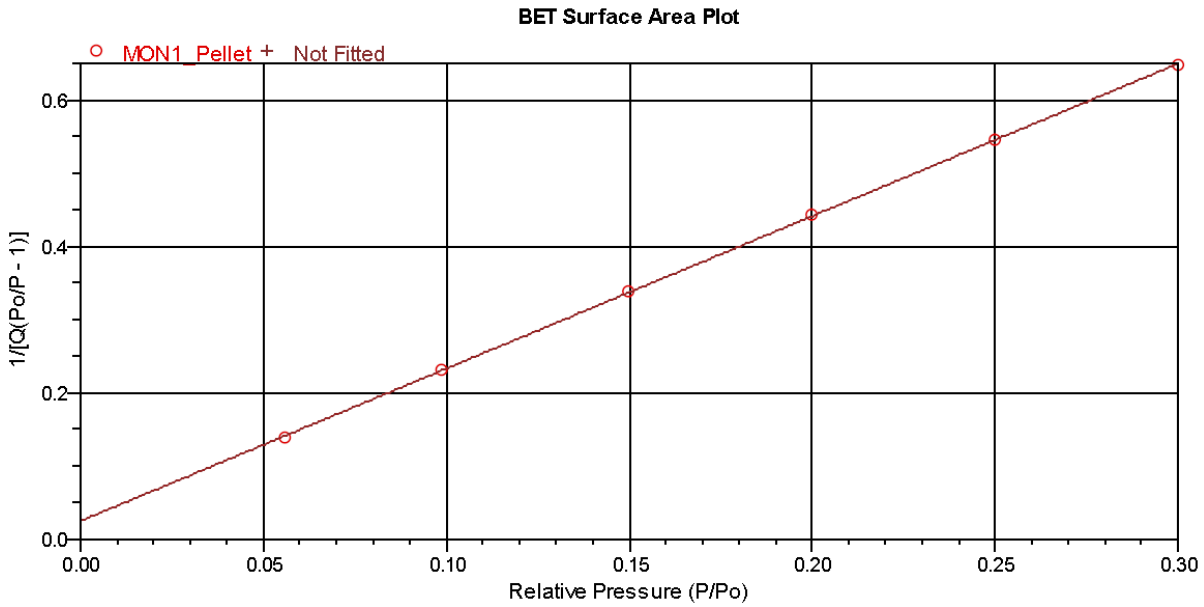
Started: 26.01.2018 15:25:10
Completed: 26.01.2018 16:48:00
Report Time: 26.01.2018 16:49:18
Sample Mass: 2,0182 g
Cold Free Space: 27,5570 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,4456 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.0662 ± 0.0111 m²/g
Slope: 2.081886 ± 0.011087 g/cm³ STP
Y-Intercept: 0.024640 ± 0.002158 g/cm³ STP
C: 85.490781
Qm: 0,4747 cm³/g STP
Correlation Coefficient: 0.9999433
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055750639	0.4283	0.137861
0.098799187	0.4740	0.231275
0.149726861	0.5200	0.338642
0.199735875	0.5646	0.442028
0.249755255	0.6112	0.544702
0.299758077	0.6620	0.646655



Sample: MON2_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MON2_Pellet.SMP

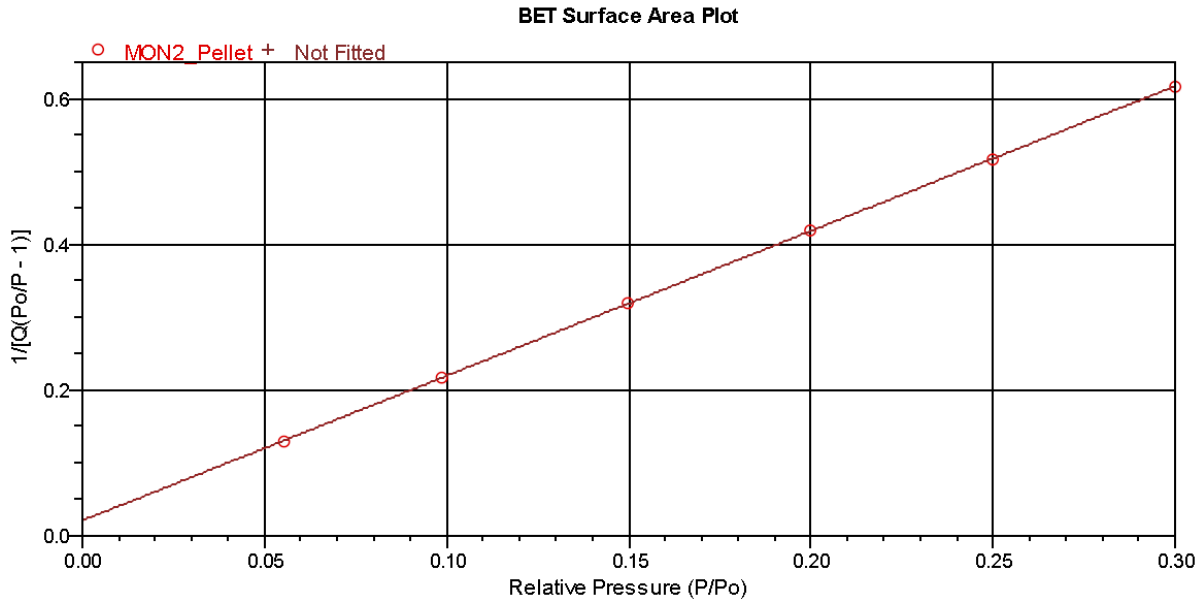
Started: 30.01.2018 14:03:02
Completed: 30.01.2018 15:23:41
Report Time: 30.01.2018 15:26:59
Sample Mass: 2,0673 g
Cold Free Space: 26,8637 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2492 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.1666 ± 0.0071 m²/g
Slope: 1.988628 ± 0.006490 g/cm³ STP
Y-Intercept: 0.020343 ± 0.001263 g/cm³ STP
C: 98.756141
Qm: 0,4978 cm³/g STP
Correlation Coefficient: 0.9999787
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055452285	0.4556	0.128850
0.098665699	0.5036	0.217358
0.149693951	0.5513	0.319355
0.199743105	0.5966	0.418376
0.249747628	0.6442	0.516772
0.299843742	0.6956	0.615663



Sample: MON3_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MON3_Pellet.SMP

Started: 30.01.2018 14:03:02
Completed: 30.01.2018 15:23:41
Report Time: 30.01.2018 15:27:10
Sample Mass: 2,0346 g
Cold Free Space: 26,9701 cm³
Low Pressure Dose: None
Automatic Degas: No

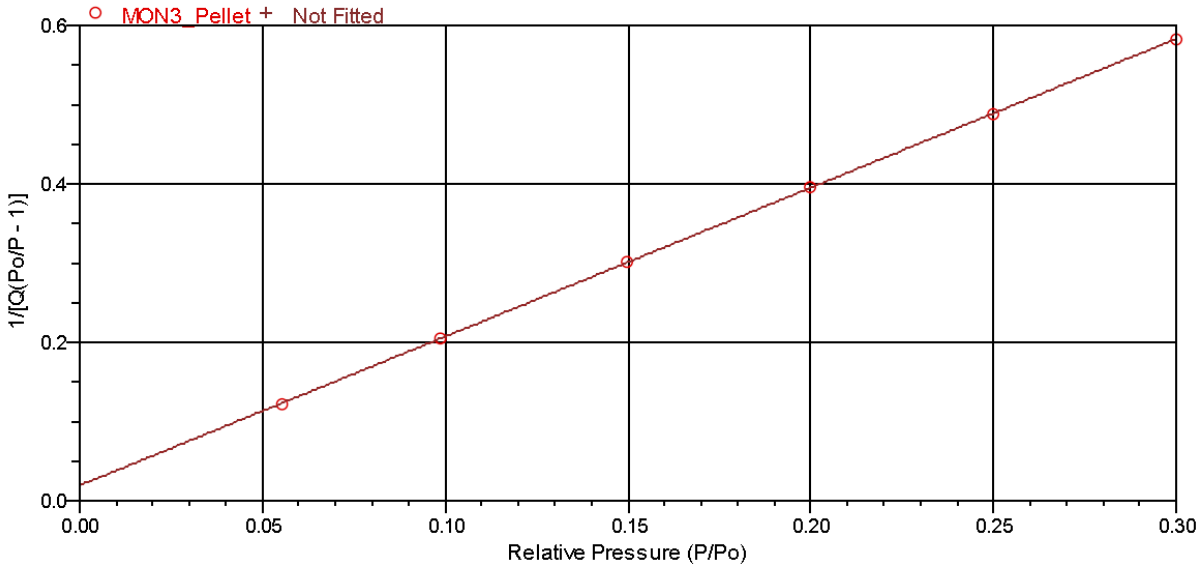
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2975 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.2918 ± 0.0073 m²/g
Slope: 1.880472 ± 0.005974 g/cm³ STP
Y-Intercept: 0.018691 ± 0.001163 g/cm³ STP
C: 101.607714
Qm: 0,5265 cm³/g STP
Correlation Coefficient: 0.9999798
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055376607	0.4837	0.121190
0.098678607	0.5340	0.205013
0.149714751	0.5841	0.301473
0.199790374	0.6320	0.395069
0.249835534	0.6820	0.488337
0.299915315	0.7363	0.581787

BET Surface Area Plot



Sample: MON4_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MON4_Pellet.SMP

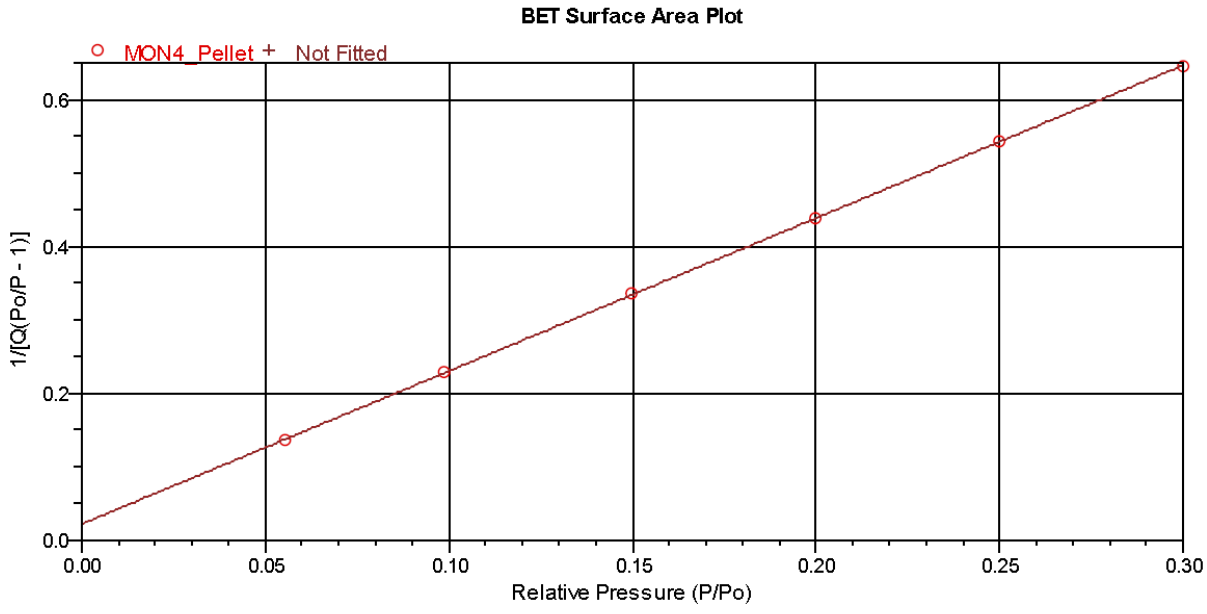
Started: 30.01.2018 14:03:02
Completed: 30.01.2018 15:23:41
Report Time: 30.01.2018 15:27:20
Sample Mass: 2,1616 g
Cold Free Space: 27,2122 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3859 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.0688 ± 0.0078 m²/g
Slope: 2.082091 ± 0.007794 g/cm³ STP
Y-Intercept: 0.021821 ± 0.001518 g/cm³ STP
C: 96.417998
Qm: 0,4753 cm³/g STP
Correlation Coefficient: 0.9999720
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055540906	0.4344	0.135384
0.098710798	0.4800	0.228172
0.149759007	0.5253	0.335313
0.199727471	0.5690	0.438639
0.249817479	0.6146	0.541811
0.299874400	0.6641	0.644943



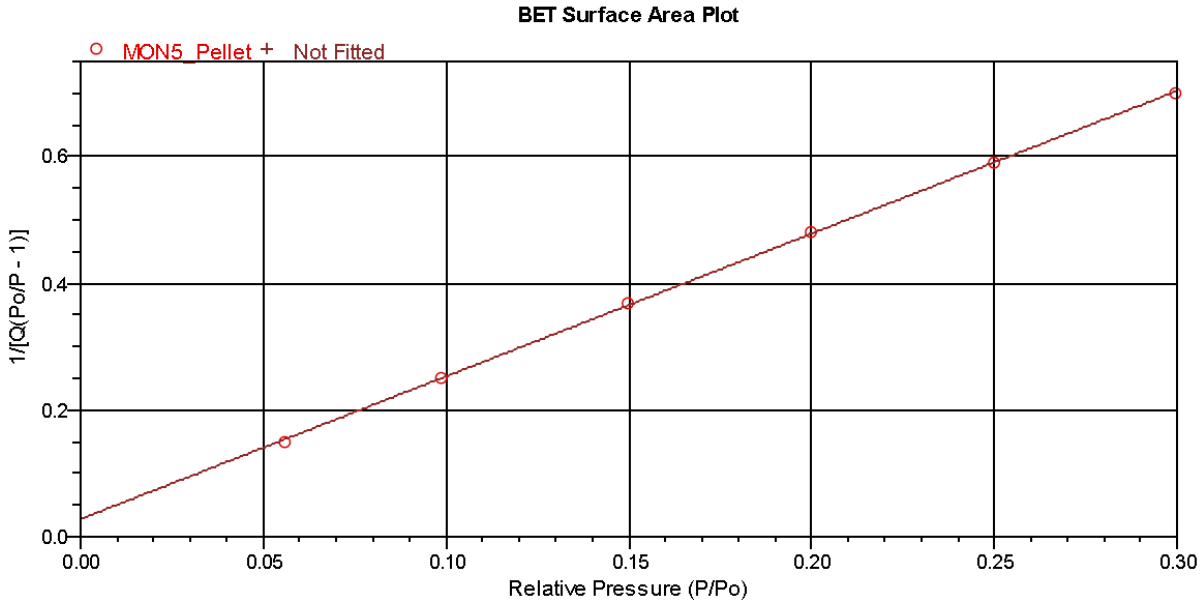
Sample: MON5_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MON5_Pellet.SMP

Started:	30.01.2018 15:42:17	Analysis Adsorptive:	N2
Completed:	30.01.2018 17:07:43	Analysis Bath Temp.:	-195,850 °C
Report Time:	30.01.2018 17:14:09	Thermal Correction:	No
Sample Mass:	2,0413 g	Warm Free Space:	9,2372 cm³ Measured
Cold Free Space:	26,7686 cm³	Equilibration Interval:	10 s
Low Pressure Dose:	None	Sample Density:	1,000 g/cm³
Automatic Degas:	No		

BET Report

BET Surface Area: 1.9090 ± 0.0104 m²/g
Slope: 2.252806 ± 0.012138 g/cm³ STP
Y-Intercept: 0.027247 ± 0.002363 g/cm³ STP
C: 83.680149
Qm: 0,4386 cm³/g STP
Correlation Coefficient: 0.9999419
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055858183	0.3945	0.149967
0.098757780	0.4370	0.250779
0.149642720	0.4798	0.366795
0.199692064	0.5209	0.478995
0.249682761	0.5643	0.589658
0.299722114	0.6112	0.700294



Mons, Obourg St. Vaast

Sample: MOV1_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MOV1_Pellet.SMP

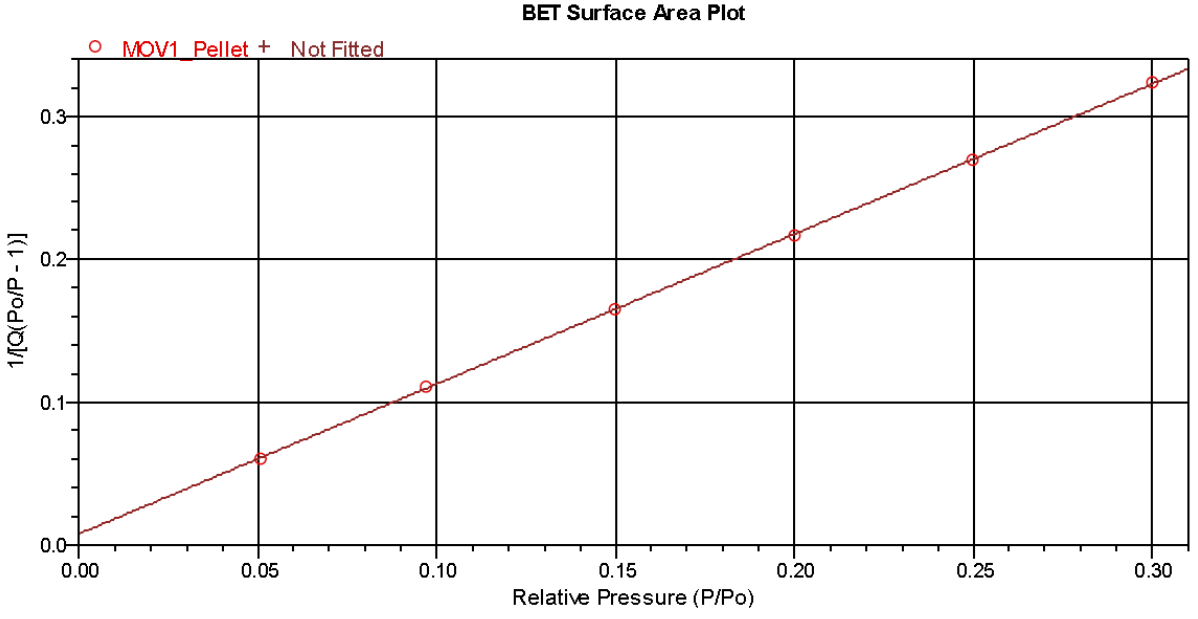
Started: 30.01.2018 15:42:17
Completed: 30.01.2018 17:07:44
Report Time: 30.01.2018 17:13:44
Sample Mass: 2,0517 g
Cold Free Space: 25,8923 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,9836 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 4.1194 ± 0.0123 m²/g
Slope: 1.048691 ± 0.003093 g/cm³ STP
Y-Intercept: 0.007922 ± 0.000601 g/cm³ STP
C: 133.370017
Qm: 0,9464 cm³/g STP
Correlation Coefficient: 0.9999826
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.050505567	0.8736	0.060887
0.097199067	0.9754	0.110380
0.149574009	1.0679	0.164698
0.199788563	1.1516	0.216794
0.249906209	1.2367	0.269401
0.300159222	1.3258	0.323492



Sample: MOV2_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MOV2_Pellet.SMP

Started: 30.01.2018 15:42:17
Completed: 30.01.2018 17:07:44
Report Time: 30.01.2018 17:13:56
Sample Mass: 2,0385 g
Cold Free Space: 27,7085 cm³
Low Pressure Dose: None
Automatic Degas: No

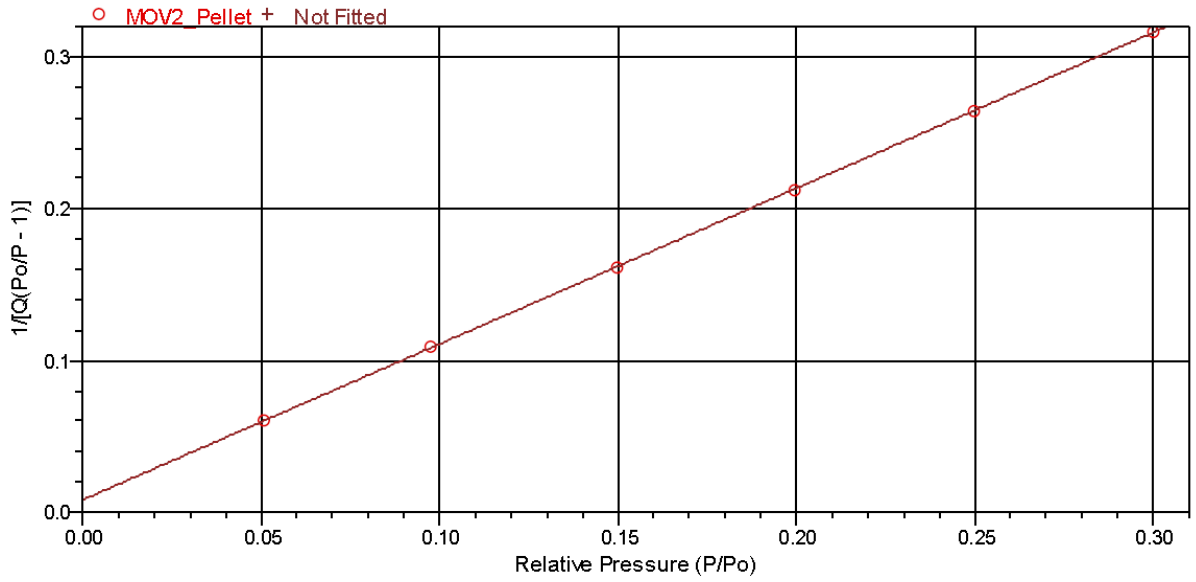
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,5074 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 4.2044 ± 0.0111 m²/g
Slope: 1.027160 ± 0.002675 g/cm³ STP
Y-Intercept: 0.008080 ± 0.000520 g/cm³ STP
C: 128.130202
Qm: 0,9660 cm³/g STP
Correlation Coefficient: 0.9999864
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.050881454	0.8897	0.060254
0.097270934	0.9931	0.108496
0.149478097	1.0874	0.161626
0.199678951	1.1734	0.212634
0.249909516	1.2608	0.264253
0.300056990	1.3526	0.316935

BET Surface Area Plot



Sample: MOV3_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MOV3_Pellet.SMP

Started: 31.01.2018 14:16:20
Completed: 31.01.2018 15:40:55
Report Time: 31.01.2018 15:42:02
Sample Mass: 2,0579 g
Cold Free Space: 27,0924 cm³
Low Pressure Dose: None
Automatic Degas: No

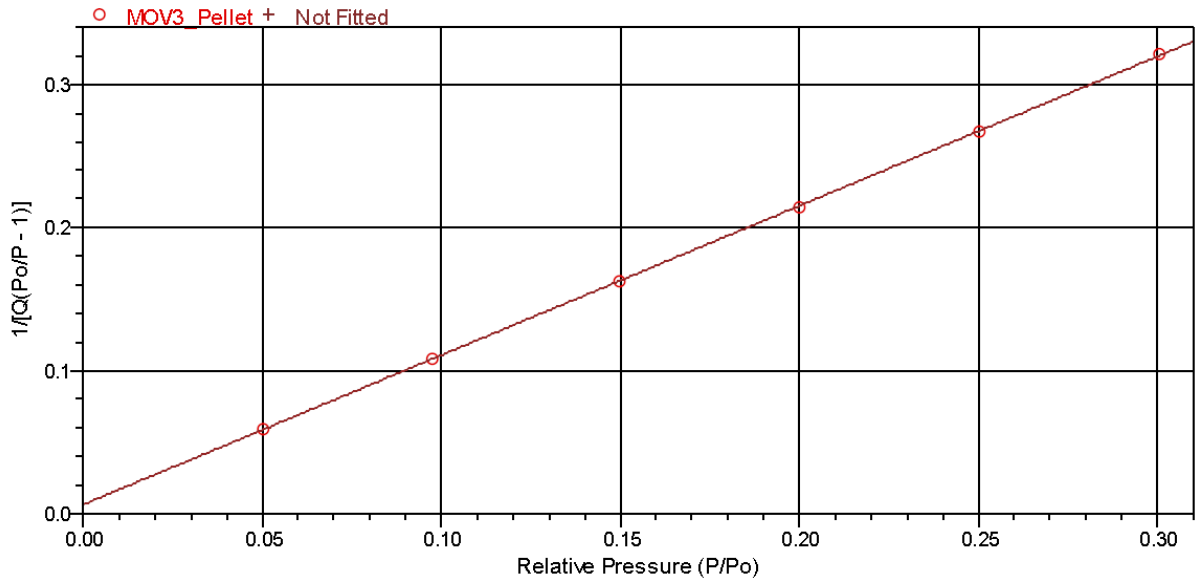
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3049 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 4.1459 ± 0.0163 m²/g
Slope: 1.043310 ± 0.004039 g/cm³ STP
Y-Intercept: 0.006531 ± 0.000786 g/cm³ STP
C: 160.739329
Qm: 0,9525 cm³/g STP
Correlation Coefficient: 0.9999700
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.050351226	0.8922	0.059429
0.097236921	0.9936	0.108409
0.149554245	1.0843	0.162189
0.199725945	1.1662	0.214000
0.250008008	1.2497	0.266748
0.300289098	1.3372	0.320930

BET Surface Area Plot



Sample: MOV4_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MOV4_Pellet.SMP

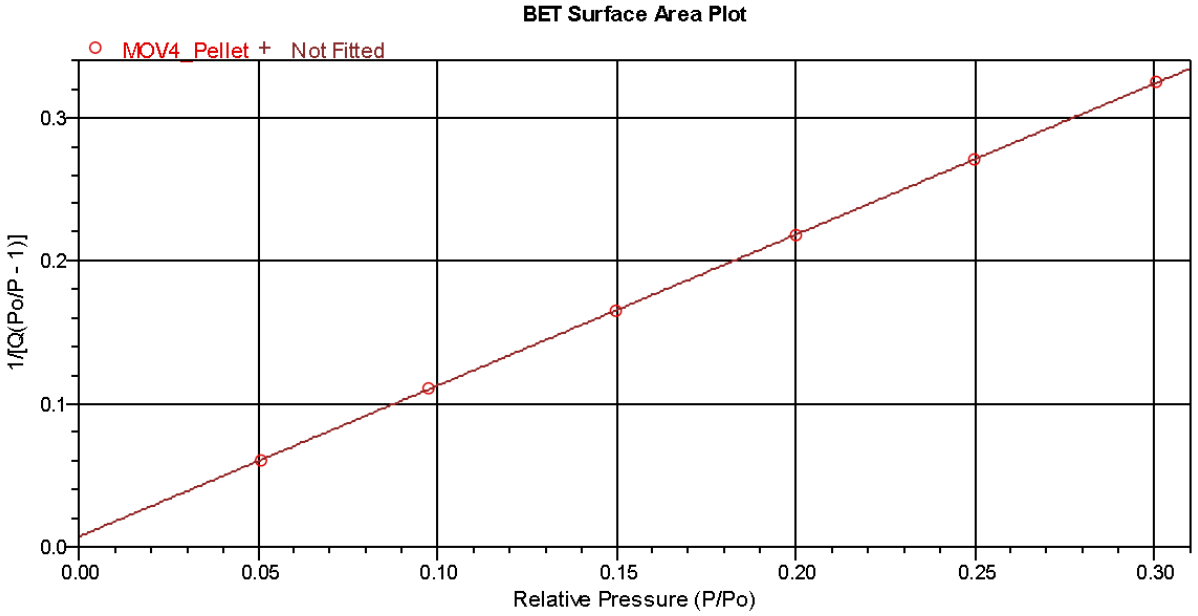
Started: 31.01.2018 14:16:20
Completed: 31.01.2018 15:40:55
Report Time: 31.01.2018 15:42:15
Sample Mass: 2,0553 g
Cold Free Space: 26,8505 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2263 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 4.0986 ± 0.0133 m²/g
Slope: 1.054660 ± 0.003389 g/cm³ STP
Y-Intercept: 0.007317 ± 0.000659 g/cm³ STP
C: 145.142151
Qm: 0,9416 cm³/g STP
Correlation Coefficient: 0.9999794
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.050608266	0.8760	0.060855
0.097283243	0.9761	0.110407
0.149512880	1.0670	0.164753
0.199812235	1.1490	0.217319
0.249928403	1.2326	0.270325
0.300279072	1.3208	0.324917



Sample: MOV5_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MOV5_Pellet.SMP

Started: 31.01.2018 14:16:20
Completed: 31.01.2018 15:40:55
Report Time: 31.01.2018 15:42:30
Sample Mass: 2,0532 g
Cold Free Space: 27,4359 cm³
Low Pressure Dose: None
Automatic Degas: No

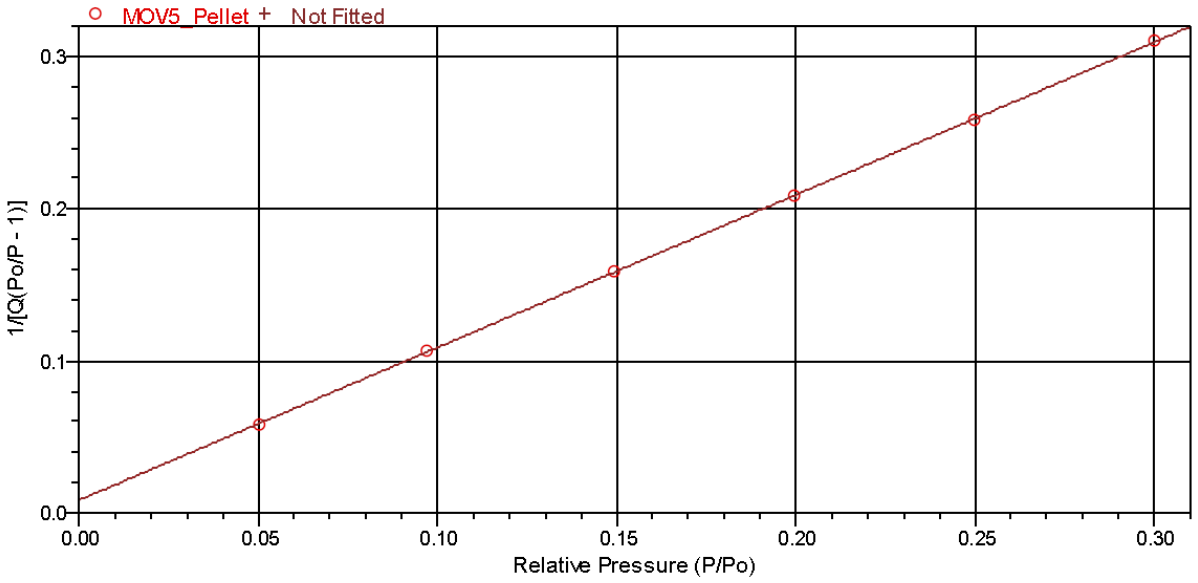
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,4189 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 4.3004 ± 0.0117 m²/g
Slope: 1.003716 ± 0.002697 g/cm³ STP
Y-Intercept: 0.008423 ± 0.000524 g/cm³ STP
C: 120.160804
Qm: 0,9880 cm³/g STP
Correlation Coefficient: 0.9999856
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.050067631	0.9012	0.058487
0.096998014	1.0102	0.106336
0.149409899	1.1085	0.158465
0.199658956	1.1973	0.208353
0.249826027	1.2878	0.258594
0.300133572	1.3821	0.310285

BET Surface Area Plot



Mons, Spiennes

Sample: MS1_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MS1_Pellet.SMP

Started: 23.01.2018 13:55:40
Completed: 23.01.2018 15:16:10
Report Time: 23.01.2018 15:18:05
Sample Mass: 2,0799 g
Cold Free Space: 27,0351 cm³
Low Pressure Dose: None
Automatic Degas: No

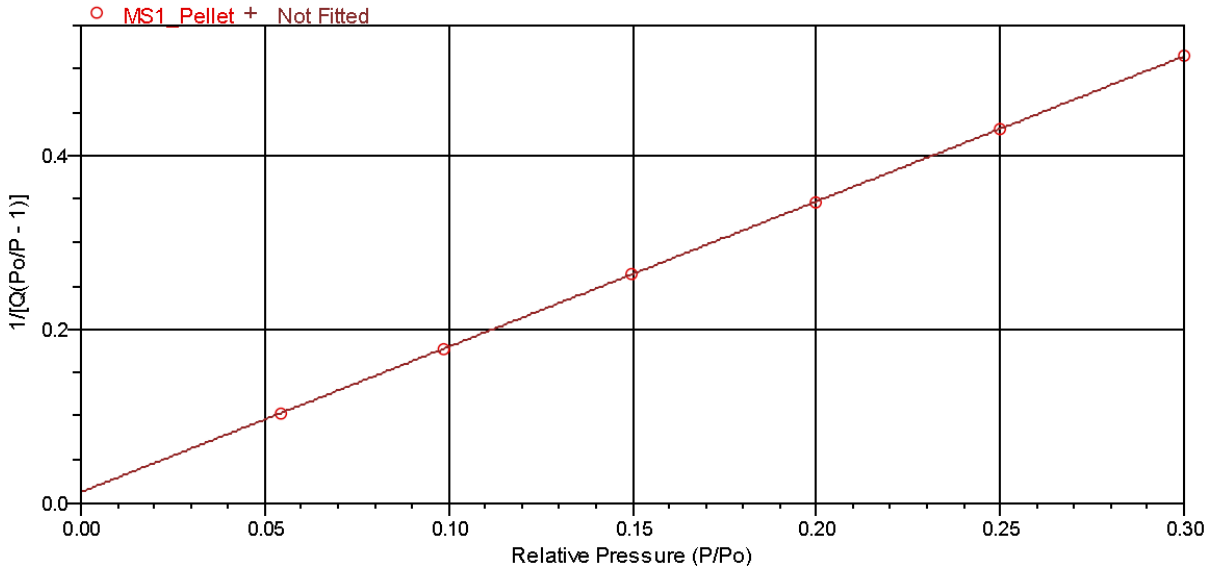
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2967 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.5817 ± 0.0042 m²/g
Slope: 1.673321 ± 0.002668 g/cm³ STP
Y-Intercept: 0.012585 ± 0.000519 g/cm³ STP
C: 133.959078
Qm: 0,5932 cm³/g STP
Correlation Coefficient: 0.9999949
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054588282	0.5576	0.103548
0.098507327	0.6138	0.178023
0.149706836	0.6686	0.263345
0.199783913	0.7205	0.346497
0.249909471	0.7744	0.430227
0.299904686	0.8320	0.514875

BET Surface Area Plot



Sample: MS2_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MS2_Pellet.SMP

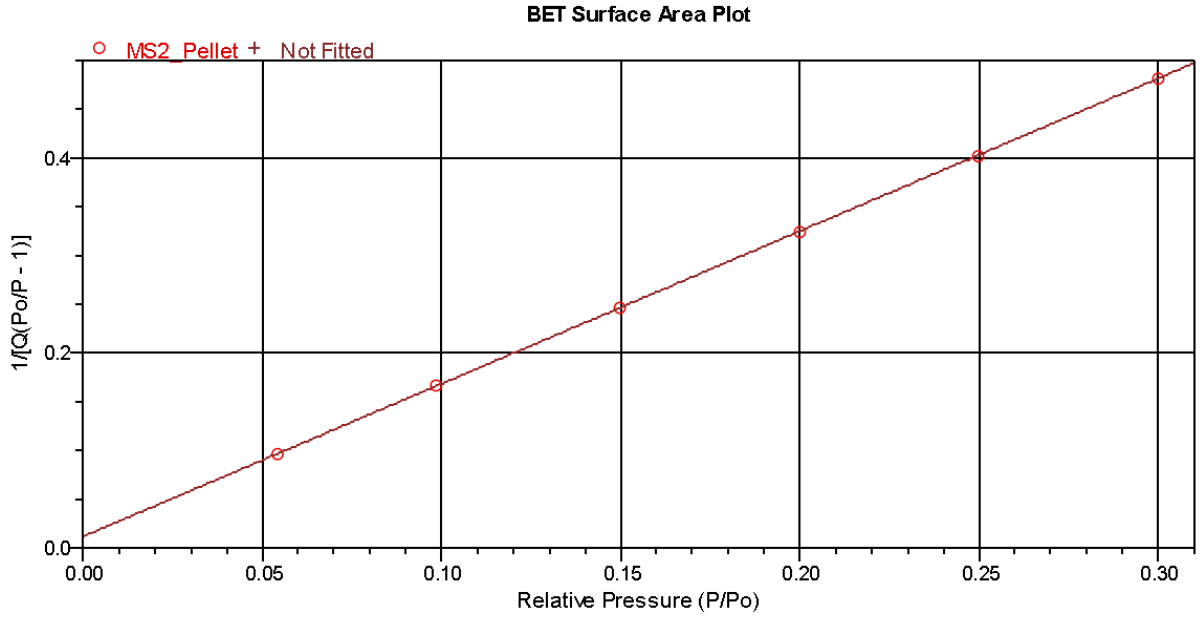
Started: 23.01.2018 13:55:40
Completed: 23.01.2018 15:16:11
Report Time: 23.01.2018 15:18:27
Sample Mass: 2,0431 g
Cold Free Space: 27,0966 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3471 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.7572 ± 0.0048 m²/g
Slope: 1.566902 ± 0.002681 g/cm³ STP
Y-Intercept: 0.011731 ± 0.000522 g/cm³ STP
C: 134.572990
Qm: 0,6335 cm³/g STP
Correlation Coefficient: 0.9999941
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054440226	0.5952	0.096724
0.098441340	0.6556	0.166549
0.149752957	0.7143	0.246567
0.199841977	0.7697	0.324493
0.249884181	0.8273	0.402671
0.300040706	0.8886	0.482389



Sample: MS3_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MS3_Pellet.SMP

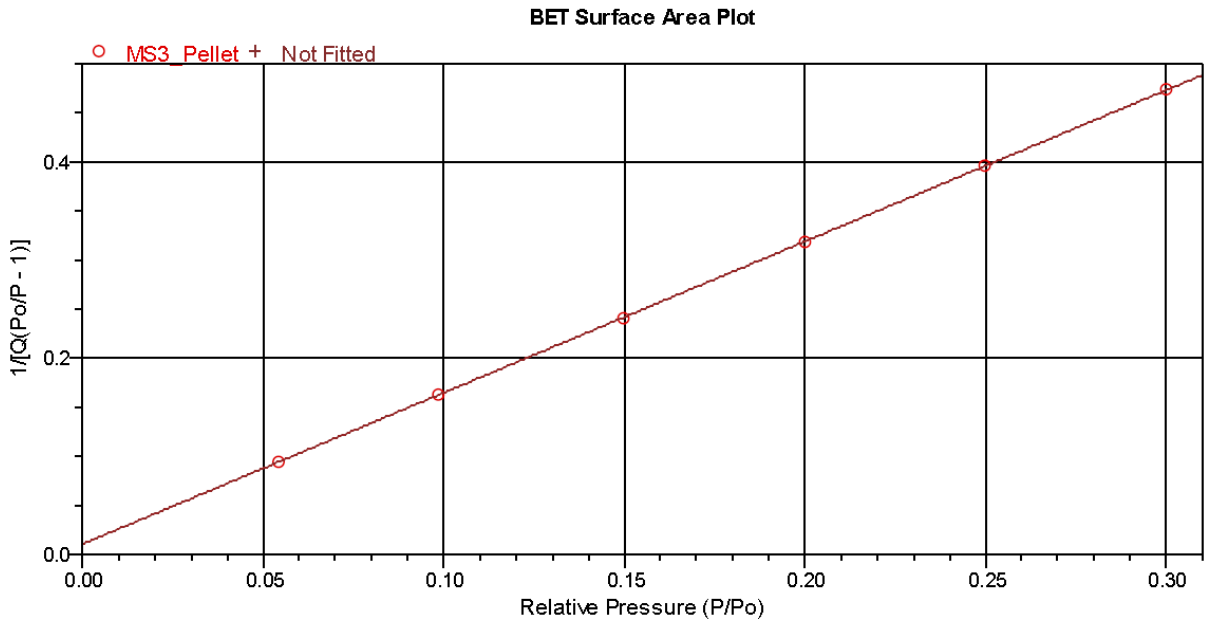
Started: 23.01.2018 13:55:40
Completed: 23.01.2018 15:16:11
Report Time: 23.01.2018 15:18:43
Sample Mass: 2,0846 g
Cold Free Space: 27,1058 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2968 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.8034 ± 0.0057 m²/g
Slope: 1.541878 ± 0.003087 g/cm³ STP
Y-Intercept: 0.010713 ± 0.000601 g/cm³ STP
C: 144.931314
Qm: 0,6441 cm³/g STP
Correlation Coefficient: 0.9999920
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054212083	0.6084	0.094219
0.098430345	0.6697	0.163019
0.149742584	0.7289	0.241608
0.199845185	0.7847	0.318285
0.249951002	0.8427	0.395442
0.300098804	0.9042	0.474191



Sample: MS4_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MS4_Pellet.SMP

Started: 23.01.2018 15:33:34
Completed: 23.01.2018 16:51:58
Report Time: 23.01.2018 16:52:21
Sample Mass: 2,0509 g
Cold Free Space: 26,7624 cm³
Low Pressure Dose: None
Automatic Degas: No

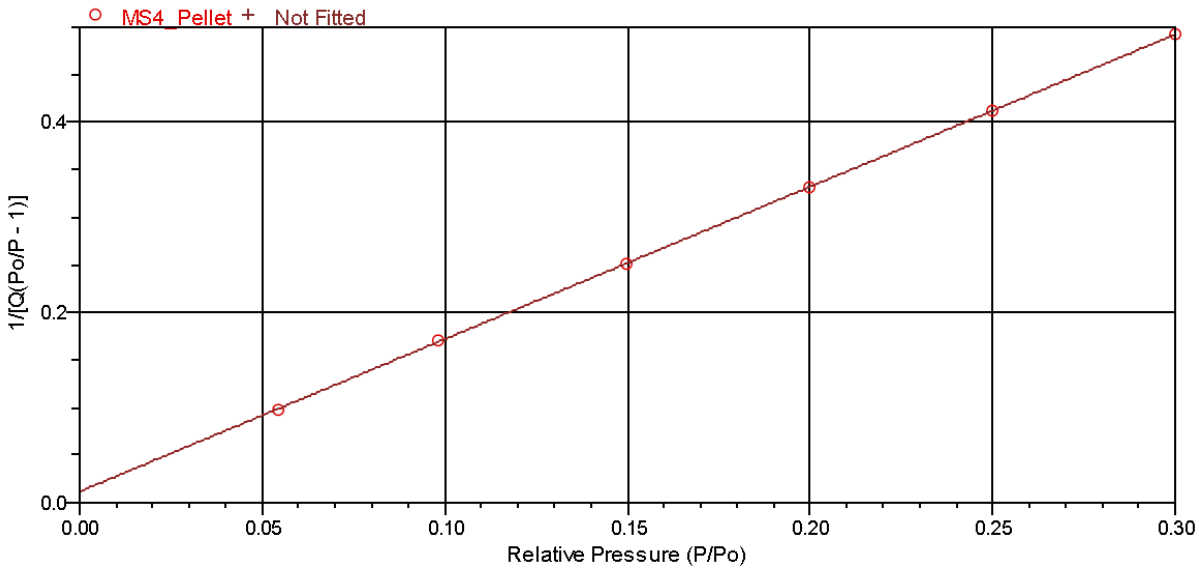
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2302 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.6963 ± 0.0046 m²/g
Slope: 1.602975 ± 0.002713 g/cm³ STP
Y-Intercept: 0.011309 ± 0.000528 g/cm³ STP
C: 142.746674
Qm: 0,6195 cm³/g STP
Correlation Coefficient: 0.9999943
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054382769	0.5850	0.098306
0.098438385	0.6436	0.169649
0.149654592	0.7004	0.251285
0.199773943	0.7542	0.331020
0.249860407	0.8099	0.411292
0.299972999	0.8696	0.492763

BET Surface Area Plot



Sample: MS5_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MS5_Pellet.SMP

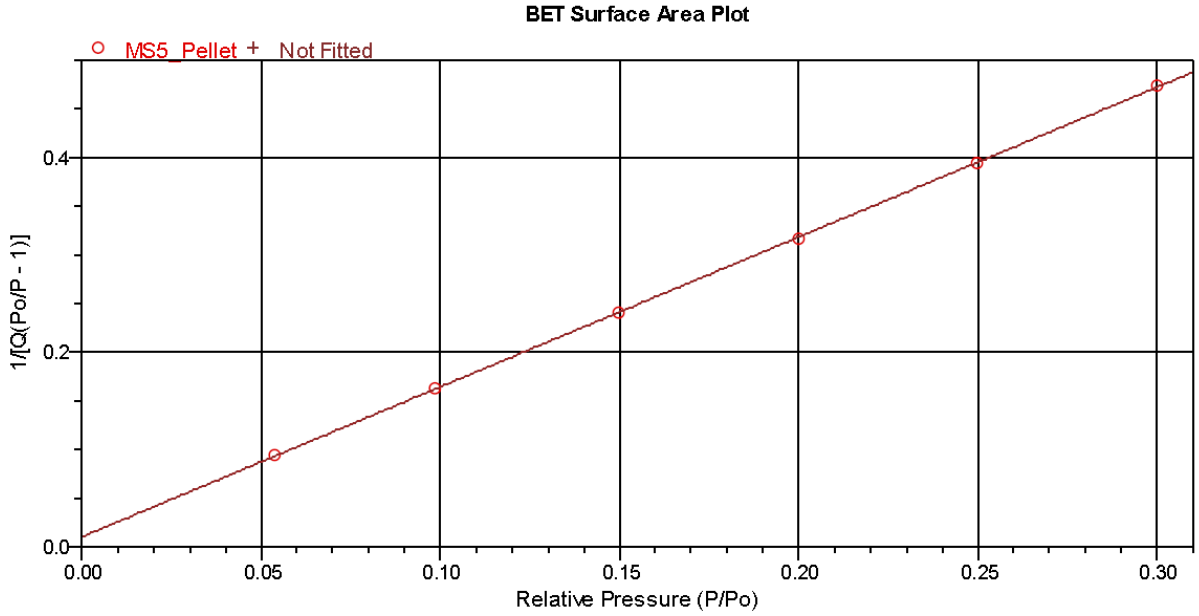
Started: 23.01.2018 15:33:34
Completed: 23.01.2018 16:51:58
Report Time: 23.01.2018 16:52:32
Sample Mass: 2,0902 g
Cold Free Space: 25,8136 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,9590 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.8069 ± 0.0063 m²/g
Slope: 1.540266 ± 0.003436 g/cm³ STP
Y-Intercept: 0.010394 ± 0.000669 g/cm³ STP
C: 149.189177
Qm: 0,6449 cm³/g STP
Correlation Coefficient: 0.9999900
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.053971311	0.6096	0.093581
0.098310052	0.6717	0.162327
0.149688466	0.7308	0.240875
0.199820111	0.7866	0.317461
0.249901317	0.8442	0.394633
0.300054727	0.9054	0.473455



Mons, Trivières

Sample: MT1_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MT1_Pellet.SMP

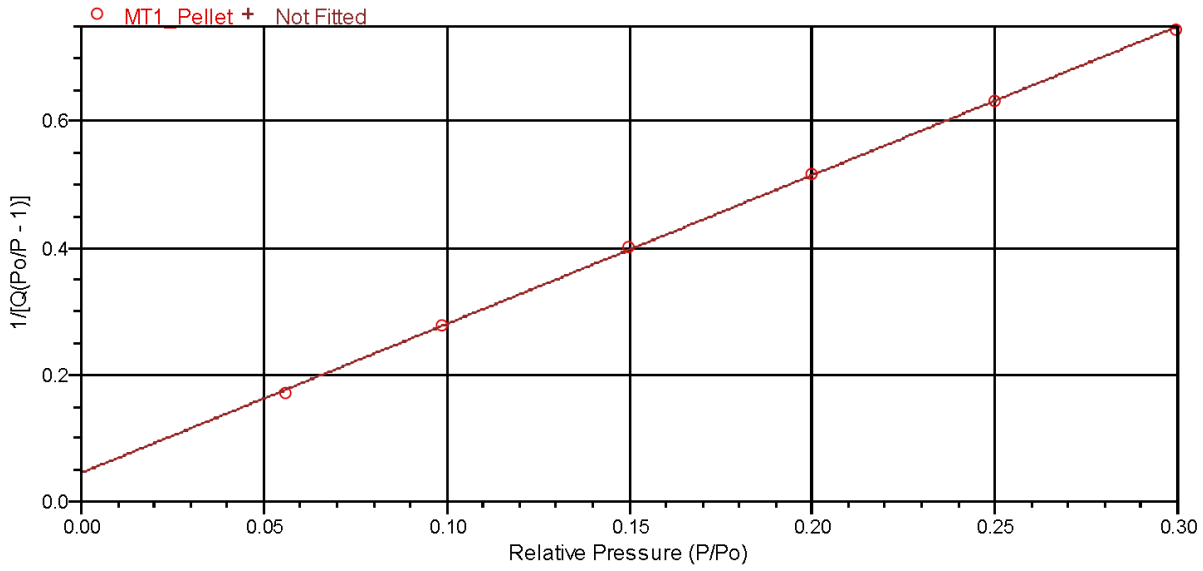
Started:	01.02.2018 14:12:50	Analysis Adsorptive:	N2
Completed:	01.02.2018 15:32:55	Analysis Bath Temp.:	-195,850 °C
Report Time:	01.02.2018 15:33:25	Thermal Correction:	No
Sample Mass:	2,0033 g	Warm Free Space:	9,3102 cm³ Measured
Cold Free Space:	27,2080 cm³	Equilibration Interval:	10 s
Low Pressure Dose:	None	Sample Density:	1,000 g/cm³
Automatic Degas:	No		

BET Report

BET Surface Area: 1.8185 ± 0.0165 m²/g
Slope: 2.348204 ± 0.021336 g/cm³ STP
Y-Intercept: 0.045261 ± 0.004152 g/cm³ STP
C: 52.881875
Qm: 0,4178 cm³/g STP
Correlation Coefficient: 0.9998349
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.056077863	0.3462	0.171596
0.098525187	0.3928	0.278210
0.149626542	0.4390	0.400829
0.199660018	0.4821	0.517429
0.249705335	0.5266	0.631963
0.299640510	0.5745	0.744747

BET Surface Area Plot



Sample: MT2_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MT2_Pellet.SMP

Started: 01.02.2018 15:44:15
Completed: 01.02.2018 17:01:38
Report Time: 01.02.2018 17:04:26
Sample Mass: 2,0584 g
Cold Free Space: 26,7754 cm³
Low Pressure Dose: None
Automatic Degas: No

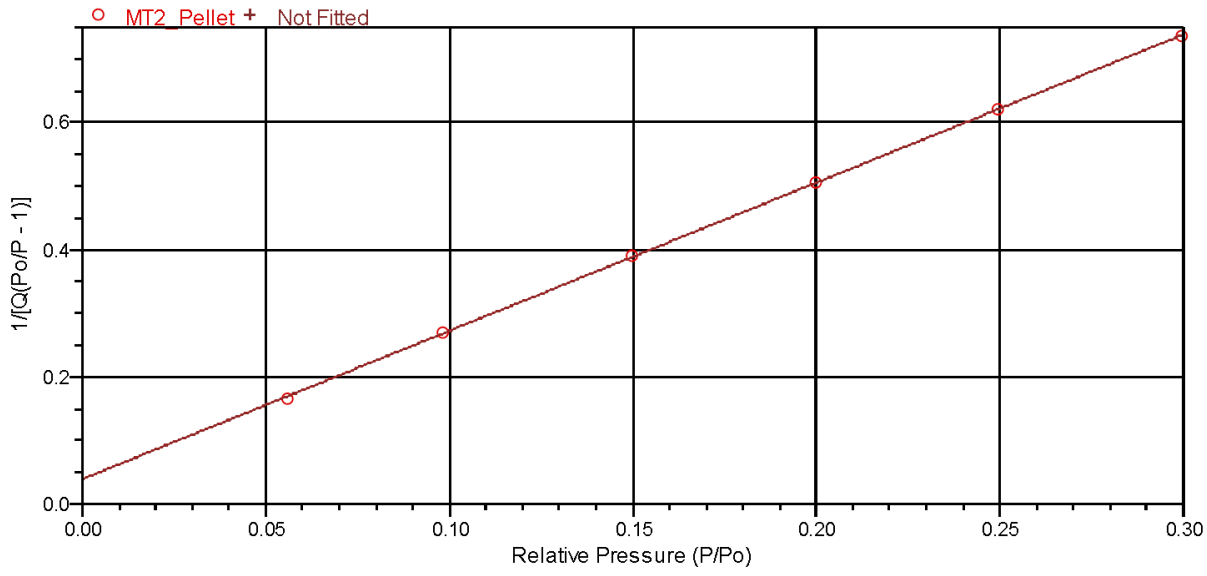
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2150 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.8366 ± 0.0128 m²/g
Slope: 2.330665 ± 0.016235 g/cm³ STP
Y-Intercept: 0.039267 ± 0.003159 g/cm³ STP
C: 60.354355
Qm: 0,4220 cm³/g STP
Correlation Coefficient: 0.9999030
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055831090	0.3580	0.165195
0.098453513	0.4042	0.270178
0.149589804	0.4497	0.391198
0.199602998	0.4920	0.506833
0.249618576	0.5356	0.621087
0.299651100	0.5824	0.734712

BET Surface Area Plot



Sample: MT3_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MT3_Pellet.SMP

Started: 01.02.2018 15:44:15
Completed: 01.02.2018 17:01:38
Report Time: 01.02.2018 17:04:36
Sample Mass: 2,1044 g
Cold Free Space: 25,8380 cm³
Low Pressure Dose: None
Automatic Degas: No

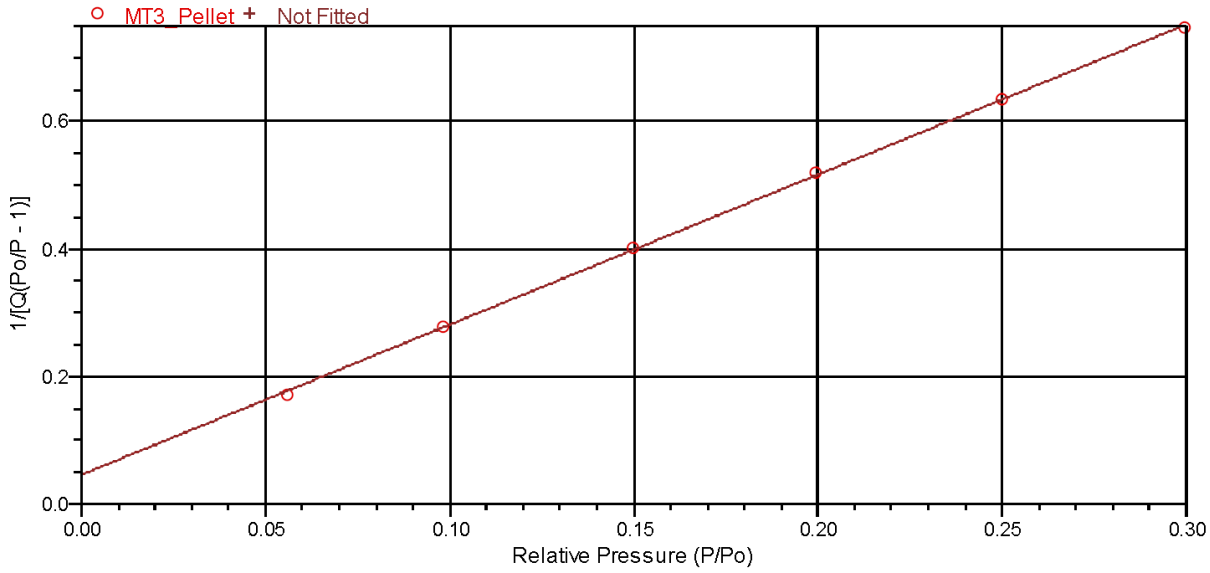
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,9440 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.8136 ± 0.0143 m²/g
Slope: 2.354174 ± 0.018618 g/cm³ STP
Y-Intercept: 0.045838 ± 0.003623 g/cm³ STP
C: 52.358372
Qm: 0,4167 cm³/g STP
Correlation Coefficient: 0.9998749
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055936839	0.3432	0.172652
0.098315152	0.3907	0.279081
0.149589420	0.4378	0.401763
0.199580835	0.4811	0.518289
0.249679912	0.5252	0.633649
0.299699500	0.5721	0.748075

BET Surface Area Plot



Sample: MT4_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MT4_Pellet.SMP

Started: 01.02.2018 15:44:15
Completed: 01.02.2018 17:01:38
Report Time: 01.02.2018 17:04:45
Sample Mass: 2,1302 g
Cold Free Space: 27,5984 cm³
Low Pressure Dose: None
Automatic Degas: No

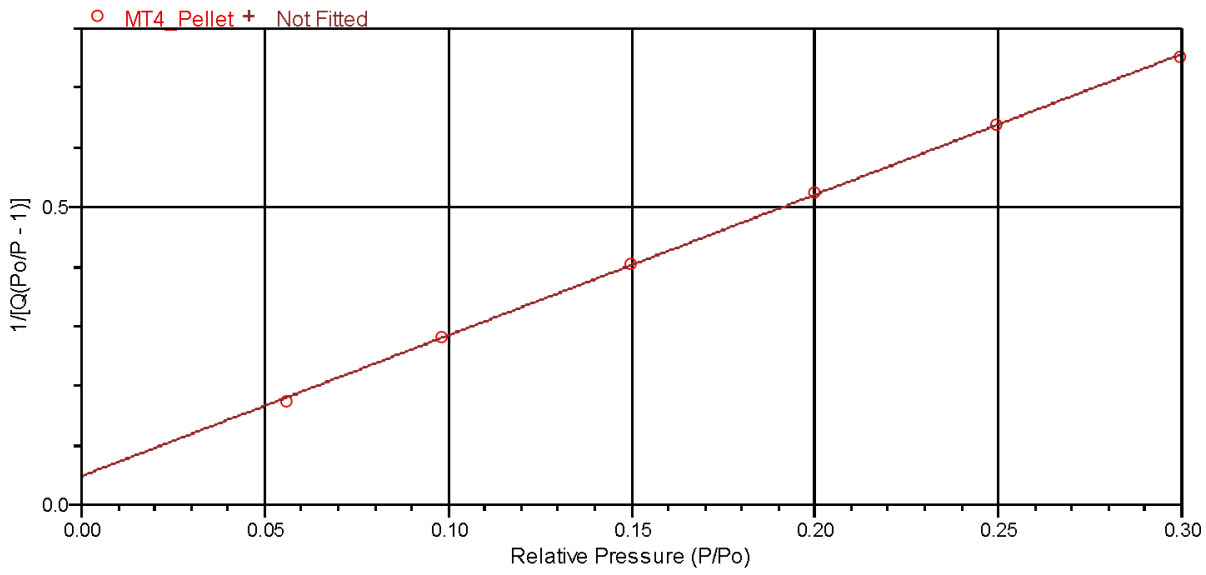
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,4557 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.8058 ± 0.0160 m²/g
Slope: 2.362076 ± 0.021000 g/cm³ STP
Y-Intercept: 0.048195 ± 0.004086 g/cm³ STP
C: 50.010439
Qm: 0,4149 cm³/g STP
Correlation Coefficient: 0.9998419
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055932470	0.3387	0.174946
0.098385064	0.3865	0.282355
0.149590451	0.4336	0.405699
0.199642396	0.4769	0.522994
0.249584899	0.5214	0.637836
0.299658505	0.5689	0.752120

BET Surface Area Plot



Sample: MT5_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MT5_Pellet.SMP

Started: 02.02.2018 13:37:29
Completed: 02.02.2018 14:58:16
Report Time: 02.02.2018 14:59:02
Sample Mass: 2,1251 g
Cold Free Space: 26,7354 cm³
Low Pressure Dose: None
Automatic Degas: No

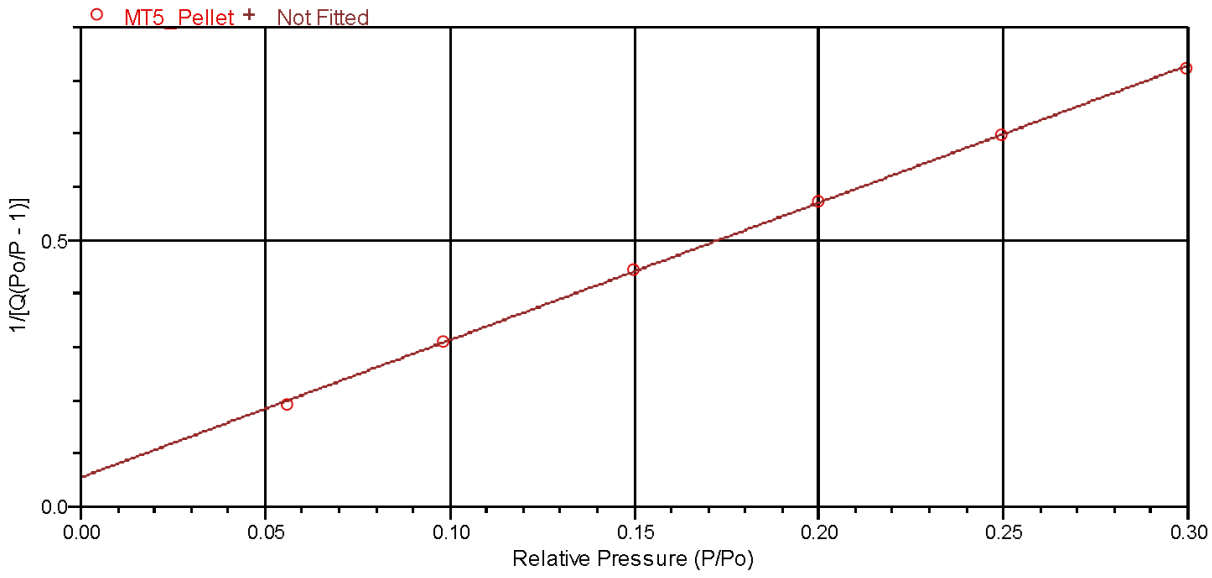
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2004 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.6542 ± 0.0160 m²/g
Slope: 2.576060 ± 0.024903 g/cm³ STP
Y-Intercept: 0.055095 ± 0.004845 g/cm³ STP
C: 47.756857
Qm: 0,3801 cm³/g STP
Correlation Coefficient: 0.9998131
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.056152835	0.3075	0.193446
0.098443303	0.3515	0.310657
0.149571168	0.3949	0.445317
0.199671787	0.4351	0.573457
0.249549942	0.4764	0.697980
0.299571602	0.5202	0.822201

BET Surface Area Plot



Stevns Klint

Sample: SK1_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\SK1_Pellet.SMP

Started: 22.01.2018 16:20:59
Completed: 22.01.2018 17:39:50
Report Time: 22.01.2018 17:40:25
Sample Mass: 2,0616 g
Cold Free Space: 26,7126 cm³
Low Pressure Dose: None
Automatic Degas: No

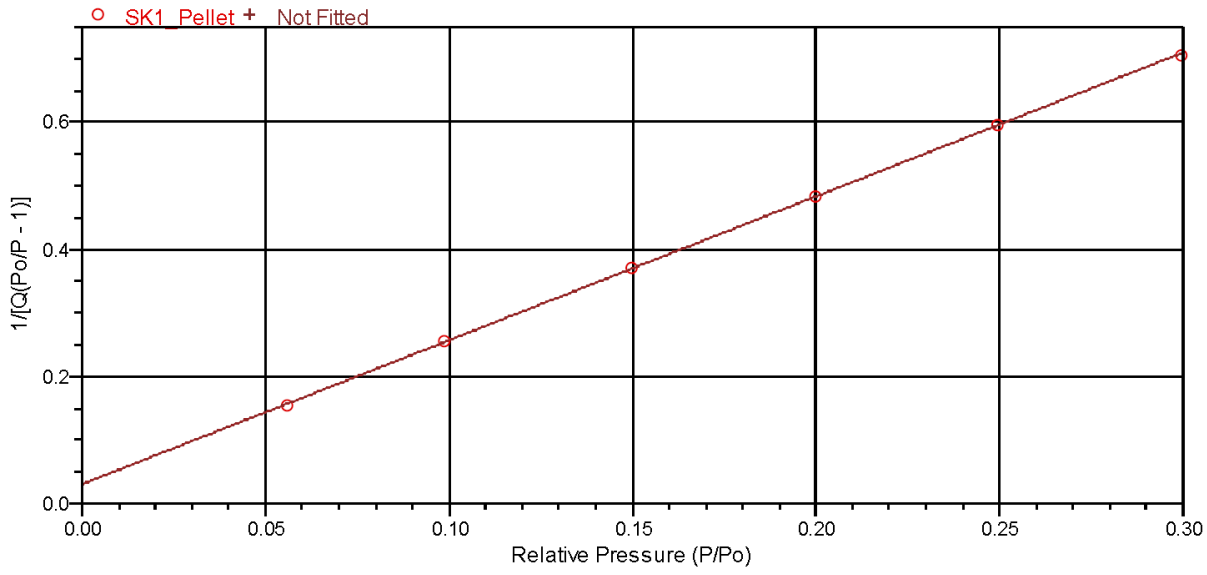
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2404 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.8972 ± 0.0113 m²/g
Slope: 2.263633 ± 0.013389 g/cm³ STP
Y-Intercept: 0.030542 ± 0.002605 g/cm³ STP
C: 75.114530
Qm: 0,4359 cm³/g STP
Correlation Coefficient: 0.9999300
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055756617	0.3850	0.153376
0.098616076	0.4294	0.254792
0.149623497	0.4730	0.371968
0.199611974	0.5148	0.484438
0.249629744	0.5585	0.595702
0.299678441	0.6058	0.706396

BET Surface Area Plot



Sample: SK2_Pellet(2)
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\SK2_Pellet(2).SMP

Started: 22.01.2018 16:20:59
Completed: 22.01.2018 17:39:51
Report Time: 22.01.2018 17:40:44
Sample Mass: 2,0314 g
Cold Free Space: 27,0390 cm³
Low Pressure Dose: None
Automatic Degas: No

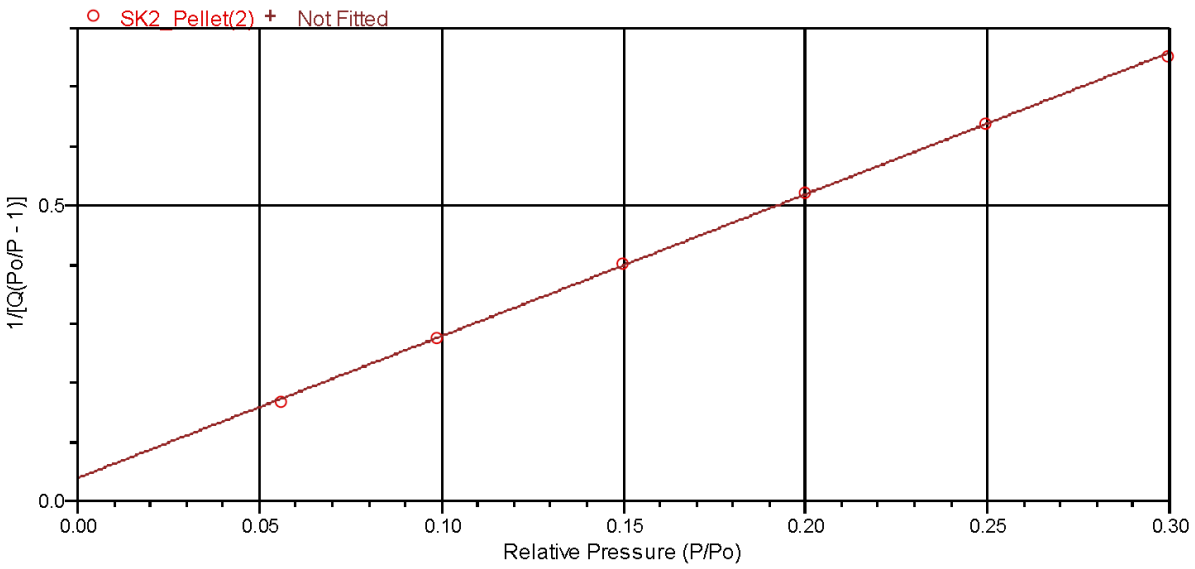
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3399 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.7853 ± 0.0156 m²/g
Slope: 2.399352 ± 0.020912 g/cm³ STP
Y-Intercept: 0.038711 ± 0.004069 g/cm³ STP
C: 62.981128
Qm: 0,4102 cm³/g STP
Correlation Coefficient: 0.9998481
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055962980	0.3531	0.167897
0.098679094	0.3956	0.276777
0.149643723	0.4380	0.401810
0.199641461	0.4786	0.521198
0.249642540	0.5213	0.638165
0.299608373	0.5678	0.753364

BET Surface Area Plot



Sample: SK3_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\SK3_P.SMP

Started: 16.01.2018 16:35:27
Completed: 16.01.2018 17:50:33
Report Time: 16.01.2018 17:51:33
Sample Mass: 1,9979 g
Cold Free Space: 26,7891 cm³
Low Pressure Dose: None
Automatic Degas: No

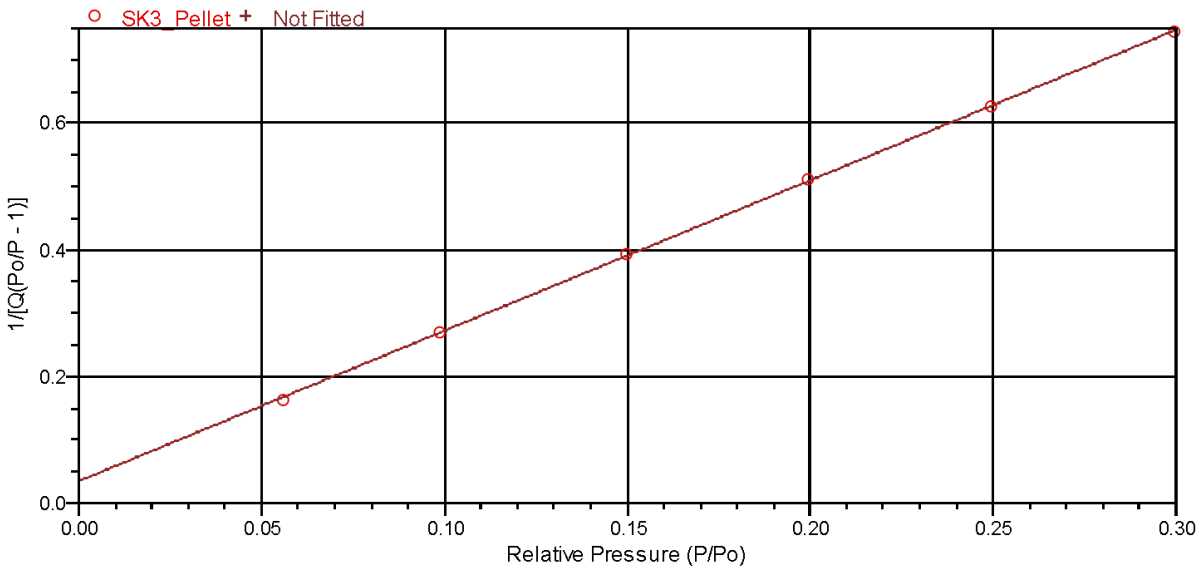
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2770 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.8064 ± 0.0125 m²/g
Slope: 2.374717 ± 0.016369 g/cm³ STP
Y-Intercept: 0.034760 ± 0.003184 g/cm³ STP
C: 69.316873
Qm: 0,4150 cm³/g STP
Correlation Coefficient: 0.9999050
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055828860	0.3622	0.163270
0.098595059	0.4050	0.270058
0.149568959	0.4474	0.393145
0.199589925	0.4876	0.511424
0.249557462	0.5299	0.627556
0.299580547	0.5756	0.743022

BET Surface Area Plot



Sample: SK4_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\SK4_P.SMP

Started: 16.01.2018 14:25:30
Completed: 16.01.2018 16:09:44
Report Time: 16.01.2018 16:21:18
Sample Mass: 1,9461 g
Cold Free Space: 25,9960 cm³
Low Pressure Dose: None
Automatic Degas: No

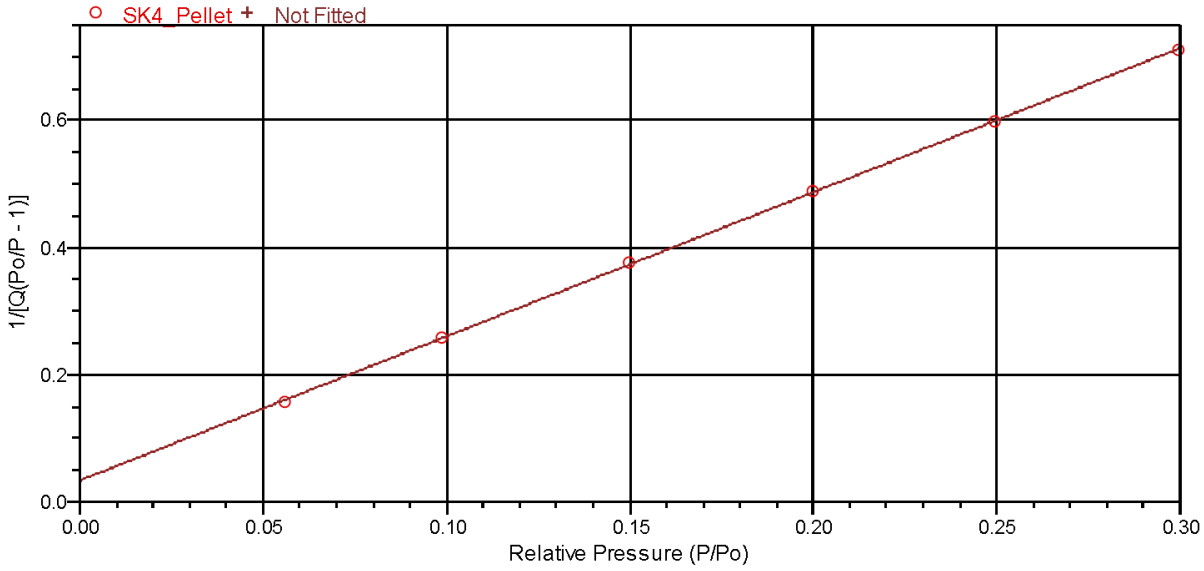
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,0327 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.8926 ± 0.0132 m²/g
Slope: 2.266128 ± 0.015697 g/cm³ STP
Y-Intercept: 0.033641 ± 0.003055 g/cm³ STP
C: 68.361943
Qm: 0,4348 cm³/g STP
Correlation Coefficient: 0.9999041
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055864838	0.3786	0.156301
0.098612217	0.4236	0.258281
0.149640090	0.4682	0.375858
0.199672858	0.5106	0.488637
0.249658842	0.5550	0.599523
0.299672953	0.6029	0.709756

BET Surface Area Plot



Sample: SK5_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\SK5_P.SMP

Started: 16.01.2018 14:25:30
Completed: 16.01.2018 16:09:44
Report Time: 16.01.2018 16:20:47
Sample Mass: 1,9297 g
Cold Free Space: 27,4639 cm³
Low Pressure Dose: None
Automatic Degas: No

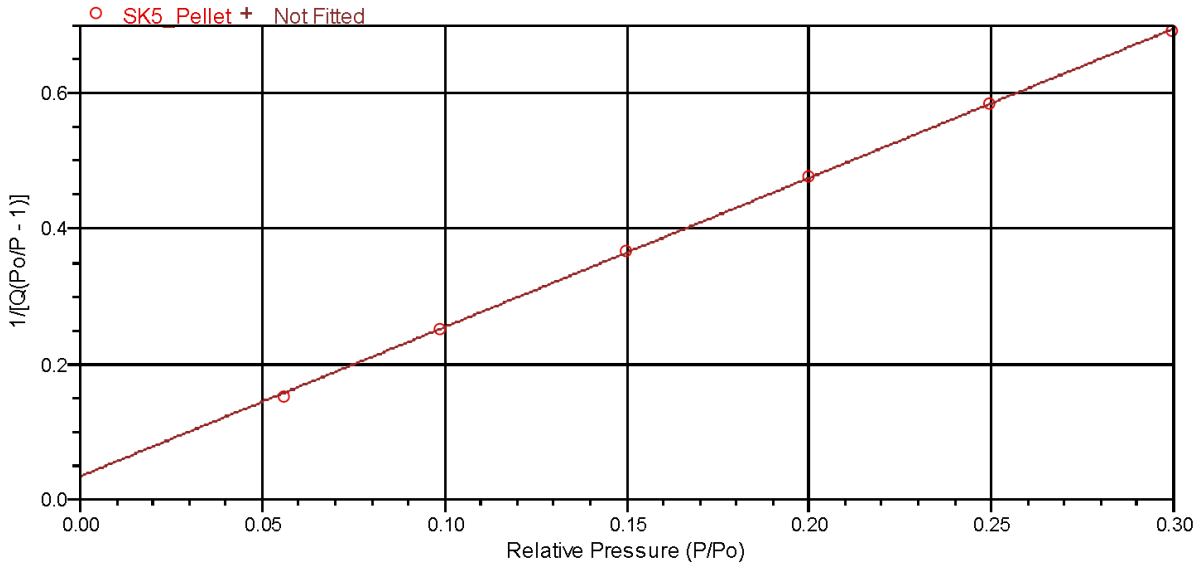
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,4652 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.9453 ± 0.0161 m²/g
Slope: 2.203312 ± 0.018156 g/cm³ STP
Y-Intercept: 0.034157 ± 0.003533 g/cm³ STP
C: 65.505643
Qm: 0,4469 cm³/g STP
Correlation Coefficient: 0.9998642
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055964354	0.3877	0.152921
0.098689294	0.4329	0.252919
0.149642857	0.4788	0.367559
0.199604911	0.5232	0.476662
0.249640927	0.5692	0.584527
0.299643069	0.6193	0.690849

BET Surface Area Plot



B. BET Report for Chalk Powder

Aalborg

Sample: A1_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\A1_Powder.SMP

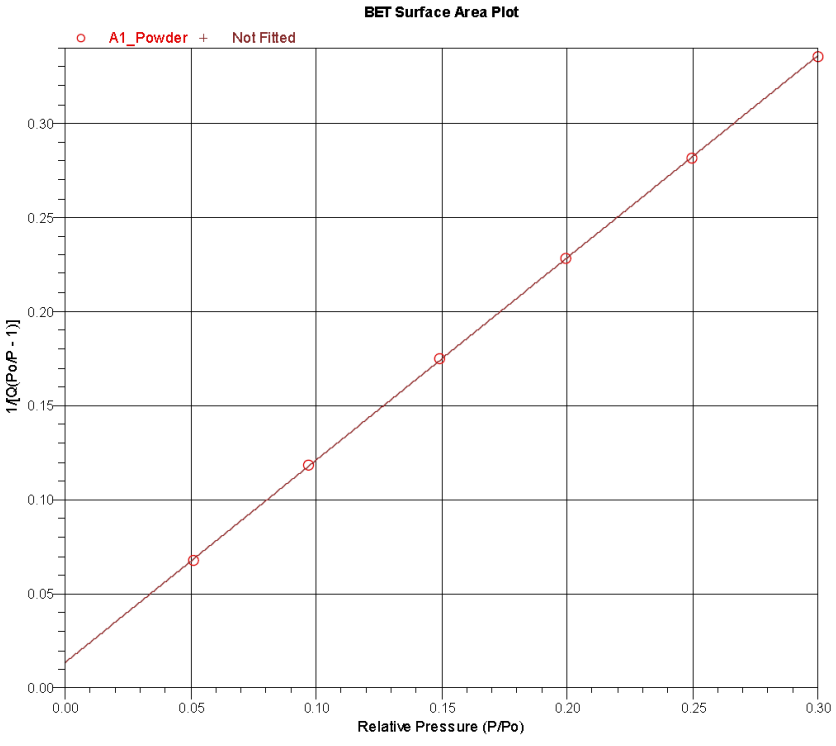
Started: 06.03.2018 13:39:33
Completed: 06.03.2018 15:00:20
Report Time: 06.03.2018 15:01:49
Sample Mass: 2,0557 g
Cold Free Space: 27,0705 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2751 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.9960 ± 0.0141 m²/g
Slope: 1.075880 ± 0.003763 g/cm³ STP
Y-Intercept: 0.013345 ± 0.000731 g/cm³ STP
C: 81.617714
Qm: 0,9181 cm³/g STP
Correlation Coefficient: 0.9999755
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.051432988	0.8018	0.067621
0.096853770	0.9066	0.118290
0.149305177	1.0043	0.174751
0.199443055	1.0923	0.228071
0.249622016	1.1815	0.281548
0.299763202	1.2755	0.335615



Sample: A2_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\A2_Powder.SMP

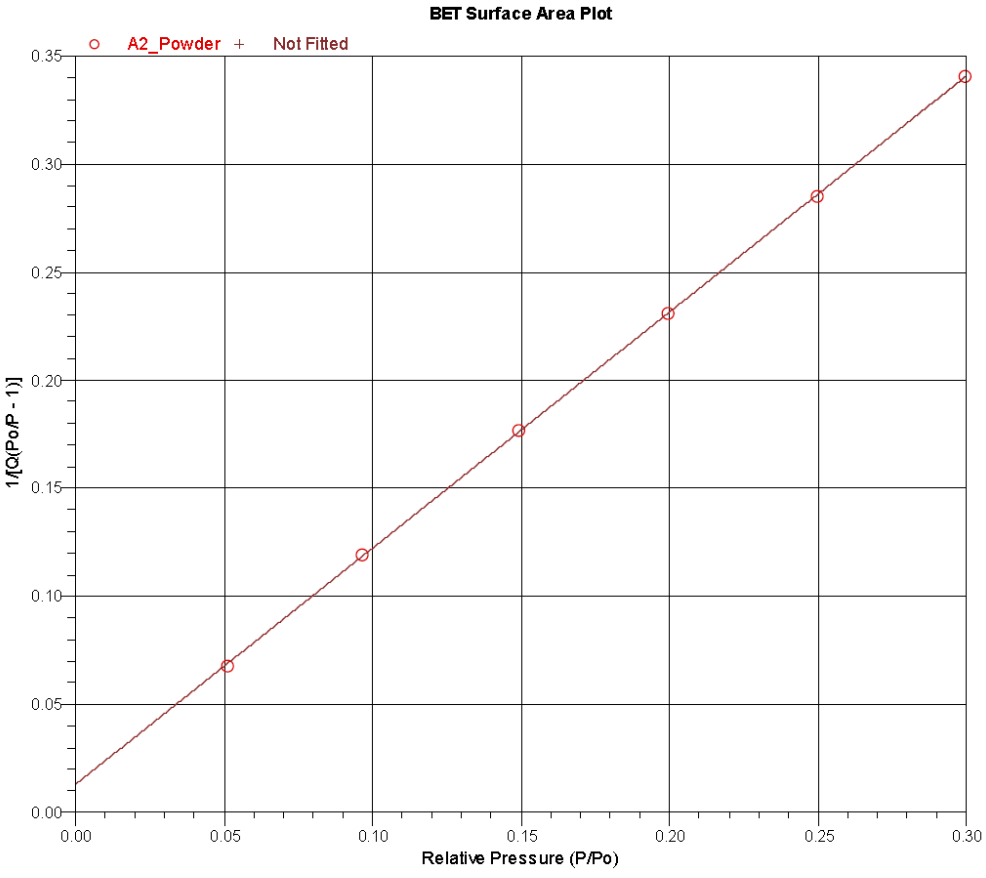
Started: 06.03.2018 15:14:27
Completed: 06.03.2018 16:33:40
Report Time: 06.03.2018 16:34:29
Sample Mass: 2,0836 g
Cold Free Space: 26,7422 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2225 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.9358 ± 0.0117 m²/g
Slope: 1.093007 ± 0.003233 g/cm³ STP
Y-Intercept: 0.012886 ± 0.000628 g/cm³ STP
C: 85.821475
Qm: 0,9042 cm³/g STP
Correlation Coefficient: 0.9999825
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.051092733	0.7936	0.067847
0.096761392	0.8976	0.119344
0.149280380	0.9932	0.176684
0.199412839	1.0789	0.230874
0.249586070	1.1658	0.285287
0.299665033	1.2572	0.340344



Sample: A3_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\A3_Powder.SMP

Started: 08.03.2018 18:03:27
Completed: 08.03.2018 19:25:24
Report Time: 08.03.2018 19:25:45
Sample Mass: 2,0609 g
Cold Free Space: 27,1480 cm³
Low Pressure Dose: None
Automatic Degas: No

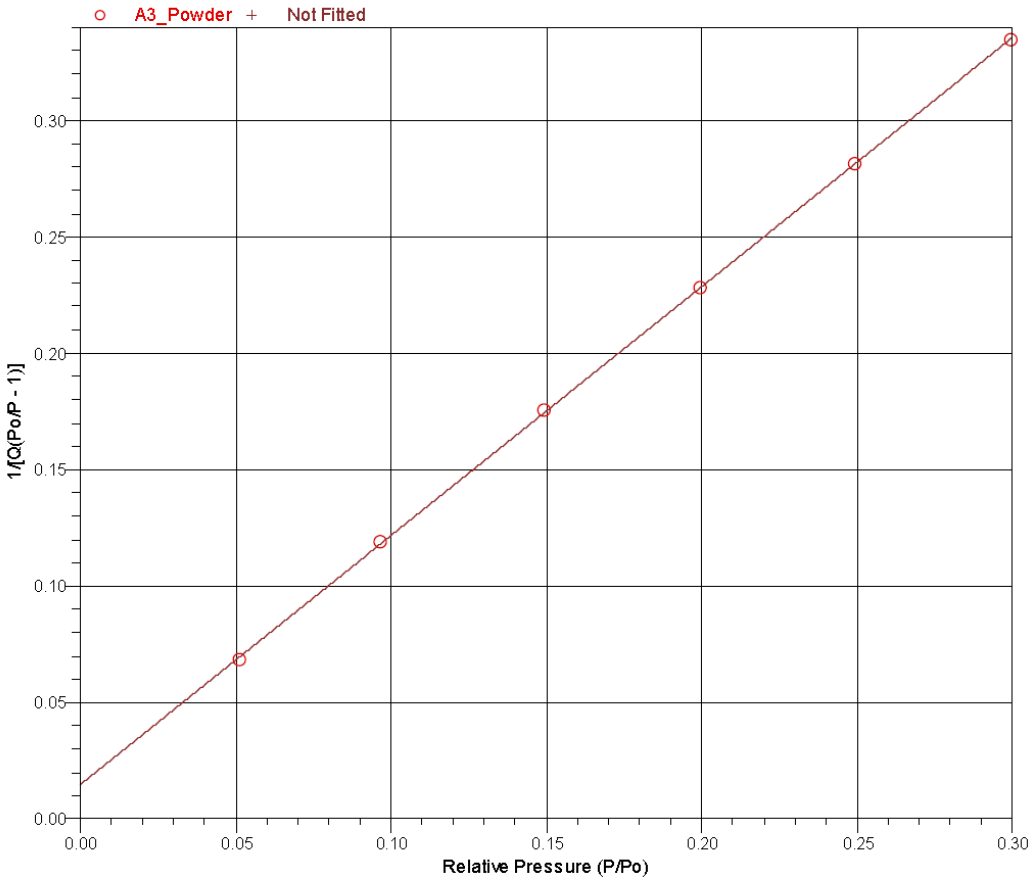
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3453 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 4.0128 ± 0.0178 m²/g
Slope: 1.070070 ± 0.004720 g/cm³ STP
Y-Intercept: 0.014606 ± 0.000916 g/cm³ STP
C: 74.259935
Qm: 0,9219 cm³/g STP
Correlation Coefficient: 0.9999611
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.051419731	0.7937	0.068295
0.096748724	0.9004	0.118966
0.149236066	1.0007	0.175287
0.199339435	1.0908	0.228250
0.249496509	1.1823	0.281186
0.299674878	1.2779	0.334856

BET Surface Area Plot



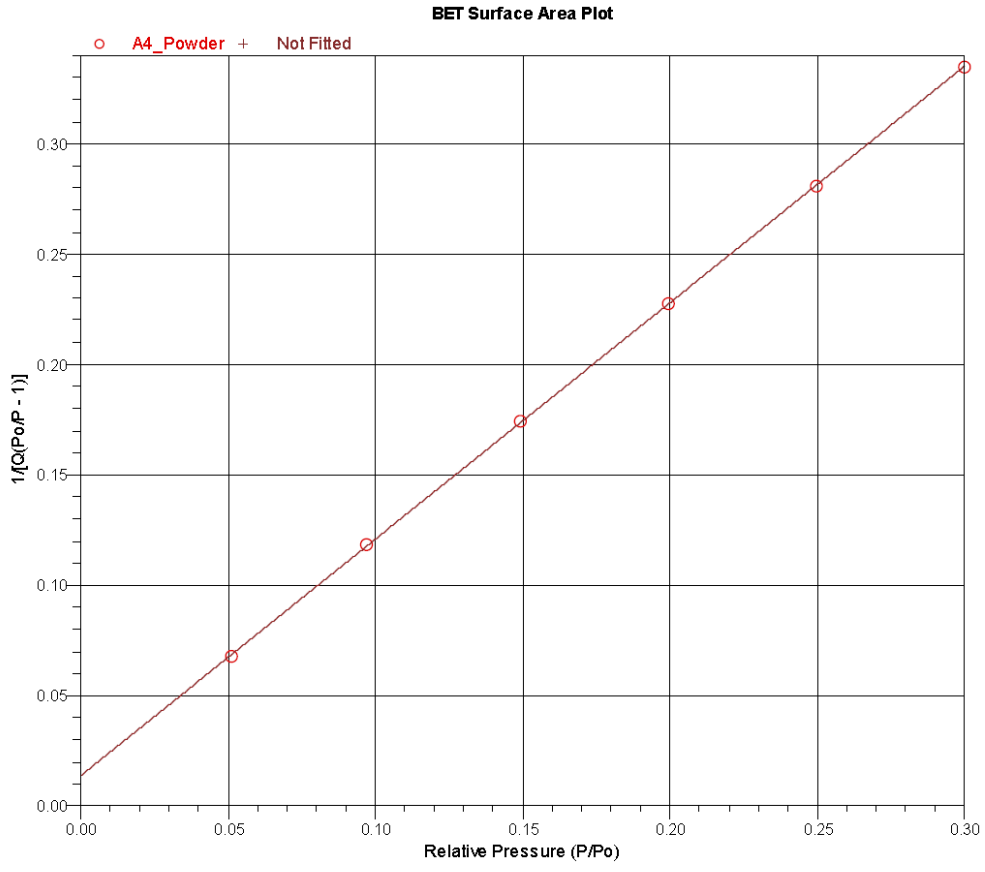
Sample: A4_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\A4_Powder.SMP

Started:	08.03.2018 18:03:27	Analysis Adsorptive:	N2
Completed:	08.03.2018 19:25:24	Analysis Bath Temp.:	-195,850 °C
Report Time:	08.03.2018 19:25:56	Thermal Correction:	No
Sample Mass:	2,0517 g	Warm Free Space:	9,2661 cm³ Measured
Cold Free Space:	26,9587 cm³	Equilibration Interval:	10 s
Low Pressure Dose:	None	Sample Density:	1,000 g/cm³
Automatic Degas:	No		

BET Report

BET Surface Area: 4.0097 ± 0.0154 m²/g
Slope: 1.071909 ± 0.004094 g/cm³ STP
Y-Intercept: 0.013597 ± 0.000795 g/cm³ STP
C: 79.832064
Qm: 0,9212 cm³/g STP
Correlation Coefficient: 0.9999708
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.051439249	0.8024	0.067583
0.096901632	0.9077	0.118206
0.149337168	1.0058	0.174536
0.199489847	1.0945	0.227687
0.249566429	1.1846	0.280733
0.299777266	1.2795	0.334605



Sample: A5_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\A5_Powder.SMP

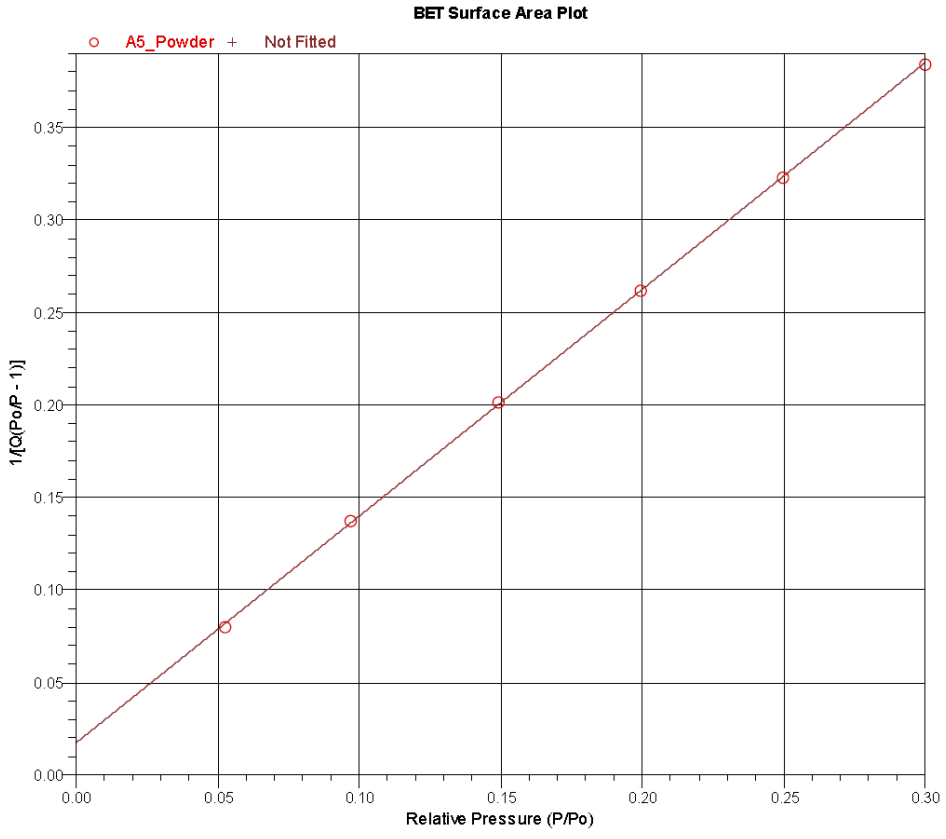
Started: 08.03.2018 18:03:27
Completed: 08.03.2018 19:25:24
Report Time: 08.03.2018 19:26:05
Sample Mass: 2,1187 g
Cold Free Space: 27,0503 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2665 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.5009 ± 0.0152 m²/g
Slope: 1.225948 ± 0.005298 g/cm³ STP
Y-Intercept: 0.017323 ± 0.001029 g/cm³ STP
C: 71.768547
Qm: 0,8043 cm³/g STP
Correlation Coefficient: 0.9999626
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.052599696	0.6913	0.080309
0.097117382	0.7835	0.137290
0.149350594	0.8710	0.201569
0.199434197	0.9503	0.262132
0.249666892	1.0300	0.323055
0.299782663	1.1140	0.384319



Kansas

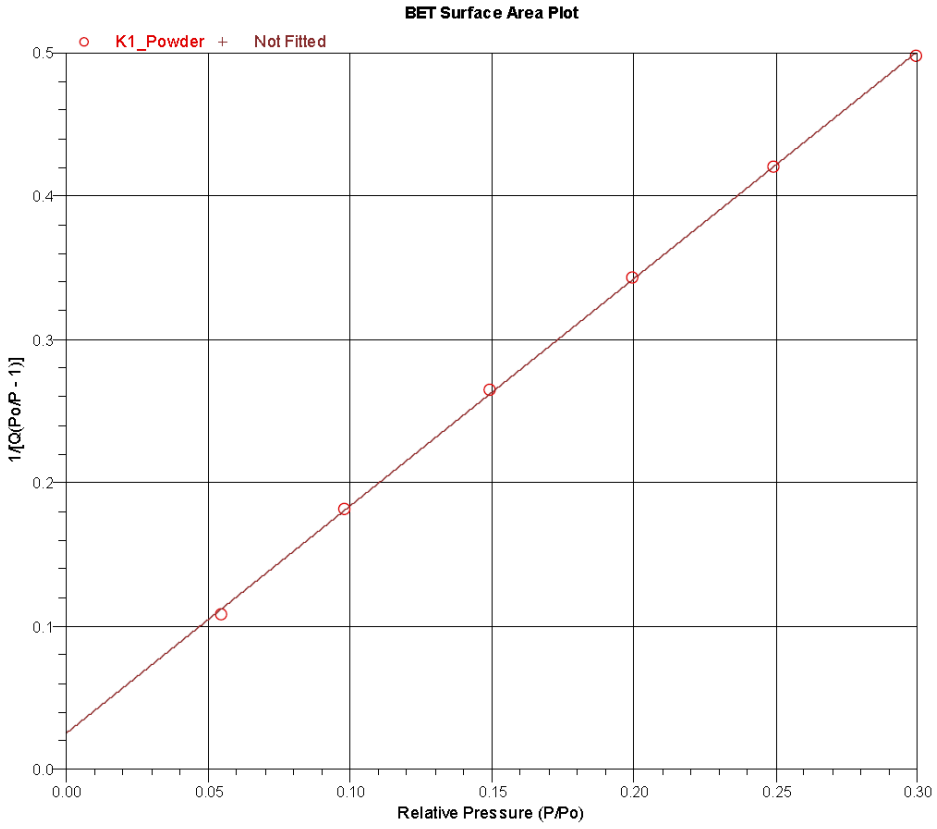
Sample: K1_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\K1_Powder.SMP

Started:	10.03.2018 13:28:26	Analysis Adsorptive:	N2
Completed:	10.03.2018 14:50:24	Analysis Bath Temp.:	-195,850 °C
Report Time:	10.03.2018 14:57:58	Thermal Correction:	No
Sample Mass:	2,0555 g	Warm Free Space:	9,3011 cm³ Measured
Cold Free Space:	26,8875 cm³	Equilibration Interval:	10 s
Low Pressure Dose:	None	Sample Density:	1,000 g/cm³
Automatic Degas:	No		

BET Report

BET Surface Area: 2.7020 ± 0.0233 m²/g
Slope: 1.585659 ± 0.013661 g/cm³ STP
Y-Intercept: 0.025242 ± 0.002655 g/cm³ STP
C: 63.819385
Qm: 0,6208 cm³/g STP
Correlation Coefficient: 0.9998516
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054661587	0.5332	0.108436
0.098052979	0.5979	0.181818
0.149444710	0.6629	0.265036
0.199401800	0.7250	0.343521
0.249453550	0.7900	0.420732
0.299449967	0.8590	0.497585



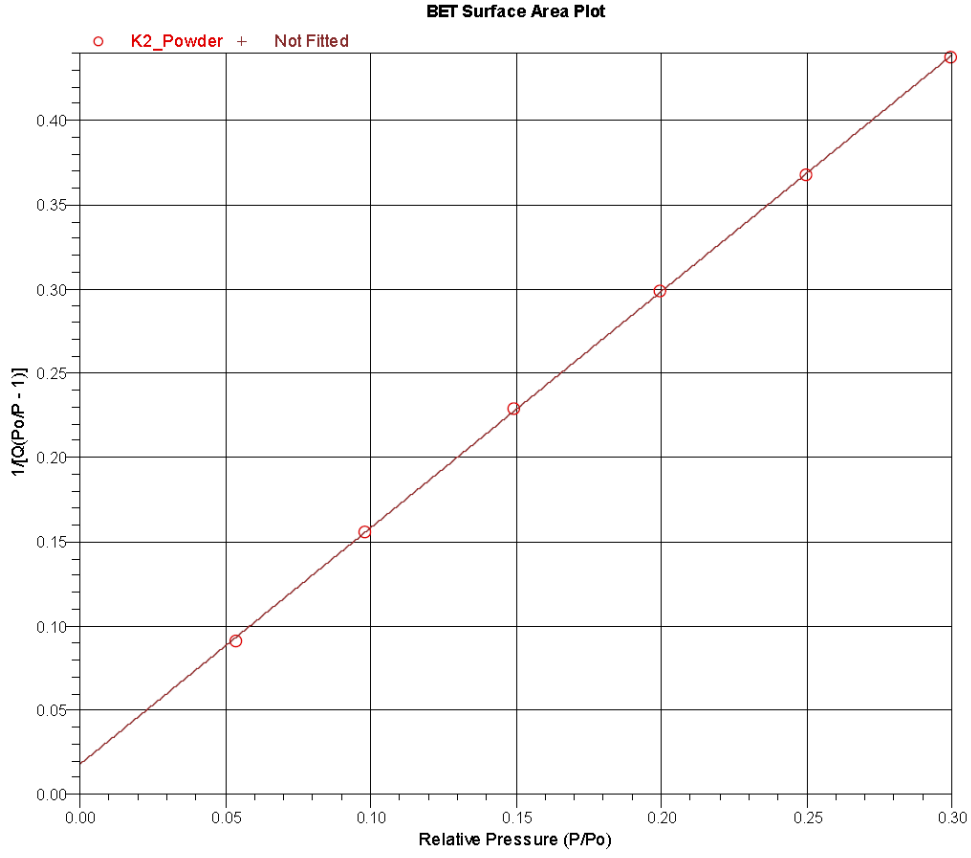
Sample: K2_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\K2_Powder.SMP

Started:	10.03.2018 13:28:26	Analysis Adsorptive:	N2
Completed:	10.03.2018 14:50:25	Analysis Bath Temp.:	-195,850 °C
Report Time:	10.03.2018 14:58:08	Thermal Correction:	No
Sample Mass:	2,0864 g	Warm Free Space:	9,0336 cm³ Measured
Cold Free Space:	25,9838 cm³	Equilibration Interval:	10 s
Low Pressure Dose:	None	Sample Density:	1,000 g/cm³
Automatic Degas:	No		

BET Report

BET Surface Area: 3.0628 ± 0.0162 m²/g
Slope: 1.403305 ± 0.007382 g/cm³ STP
Y-Intercept: 0.017807 ± 0.001435 g/cm³ STP
C: 79.807100
Qm: 0,7037 cm³/g STP
Correlation Coefficient: 0.9999447
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.053635108	0.6223	0.091076
0.097828959	0.6953	0.155965
0.149464327	0.7670	0.229122
0.199528886	0.8343	0.298760
0.249604239	0.9045	0.367746
0.299673589	0.9786	0.437271



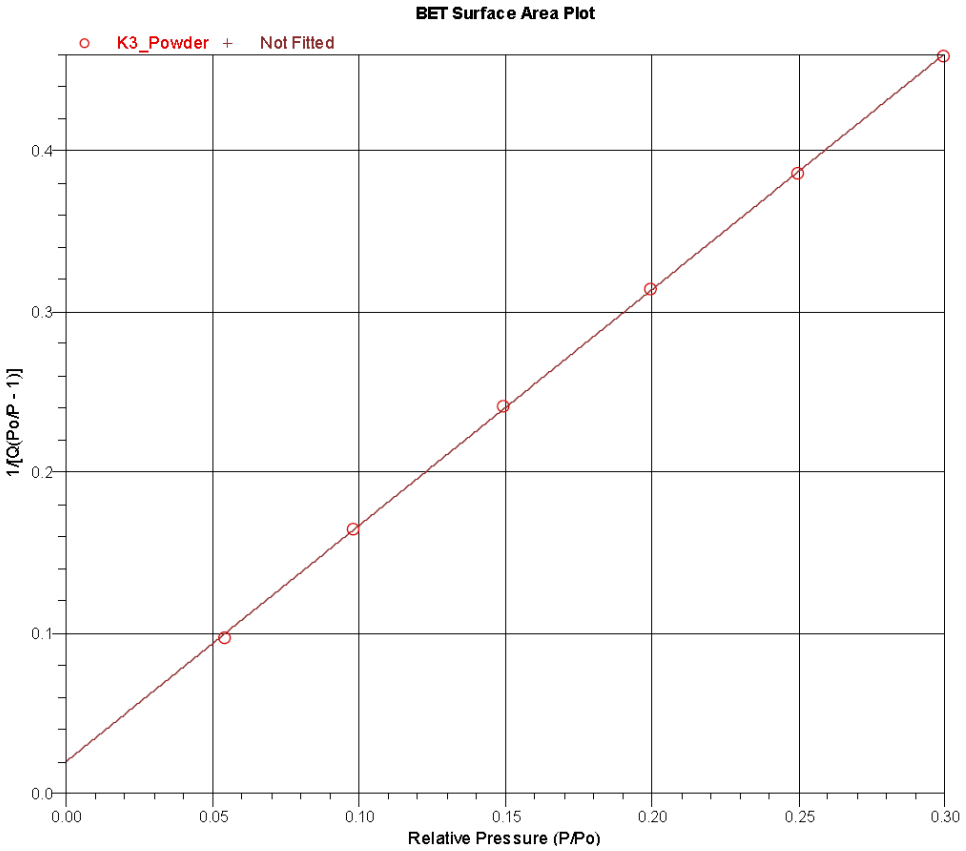
Sample: K3_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\K3_Powder.SMP

Started:	10.03.2018 13:28:26	Analysis Adsorptive:	N2
Completed:	10.03.2018 14:50:25	Analysis Bath Temp.:	-195,850 °C
Report Time:	10.03.2018 14:58:19	Thermal Correction:	No
Sample Mass:	2,0486 g	Warm Free Space:	9,3999 cm³ Measured
Cold Free Space:	27,4552 cm³	Equilibration Interval:	10 s
Low Pressure Dose:	None	Sample Density:	1,000 g/cm³
Automatic Degas:	No		

BET Report

BET Surface Area:	2.9223 ± 0.0178 m²/g
Slope:	1.469642 ± 0.008900 g/cm³ STP
Y-Intercept:	0.019795 ± 0.001730 g/cm³ STP
C:	75.244531
Qm:	0,6714 cm³/g STP
Correlation Coefficient:	0.9999267
Molecular Cross-Sectional Area:	0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054088678	0.5901	0.096908
0.098000889	0.6593	0.164782
0.149484251	0.7281	0.241393
0.199553902	0.7934	0.314235
0.249514652	0.8608	0.386220
0.299651254	0.9326	0.458786



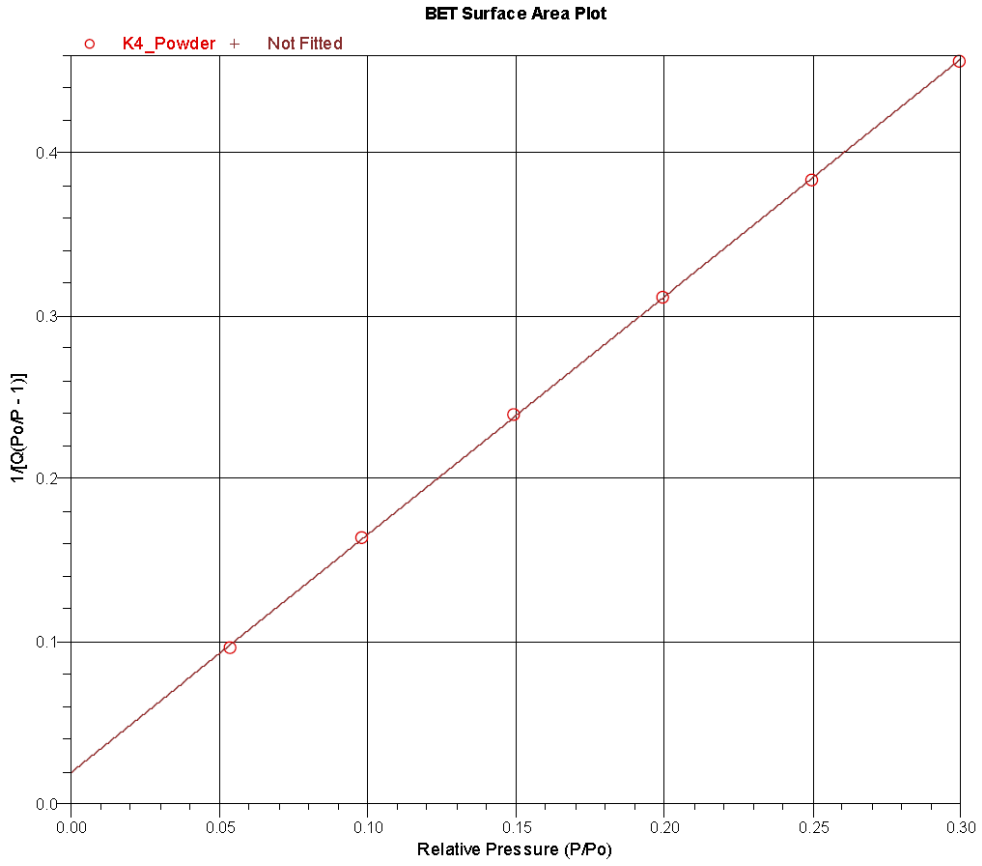
Sample: K4_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\K4_Powder.SMP

Started:	10.03.2018 17:25:24	Analysis Adsorptive:	N2
Completed:	10.03.2018 18:45:53	Analysis Bath Temp.:	-195,850 °C
Report Time:	12.03.2018 08:37:04	Thermal Correction:	No
Sample Mass:	2,0510 g	Warm Free Space:	9,2761 cm³ Measured
Cold Free Space:	26,9357 cm³	Equilibration Interval:	10 s
Low Pressure Dose:	None	Sample Density:	1,000 g/cm³
Automatic Degas:	No		

BET Report

BET Surface Area: 2.9378 ± 0.0142 m²/g
Slope: 1.462400 ± 0.007033 g/cm³ STP
Y-Intercept: 0.019187 ± 0.001367 g/cm³ STP
C: 77.217017
Qm: 0,6750 cm³/g STP
Correlation Coefficient: 0.9999537
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.053818133	0.5929	0.095938
0.097856511	0.6643	0.163280
0.149413082	0.7344	0.239174
0.199497843	0.7996	0.311662
0.249582067	0.8664	0.383872
0.299698107	0.9374	0.456522



Sample: K5_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\K5_Powder.SMP

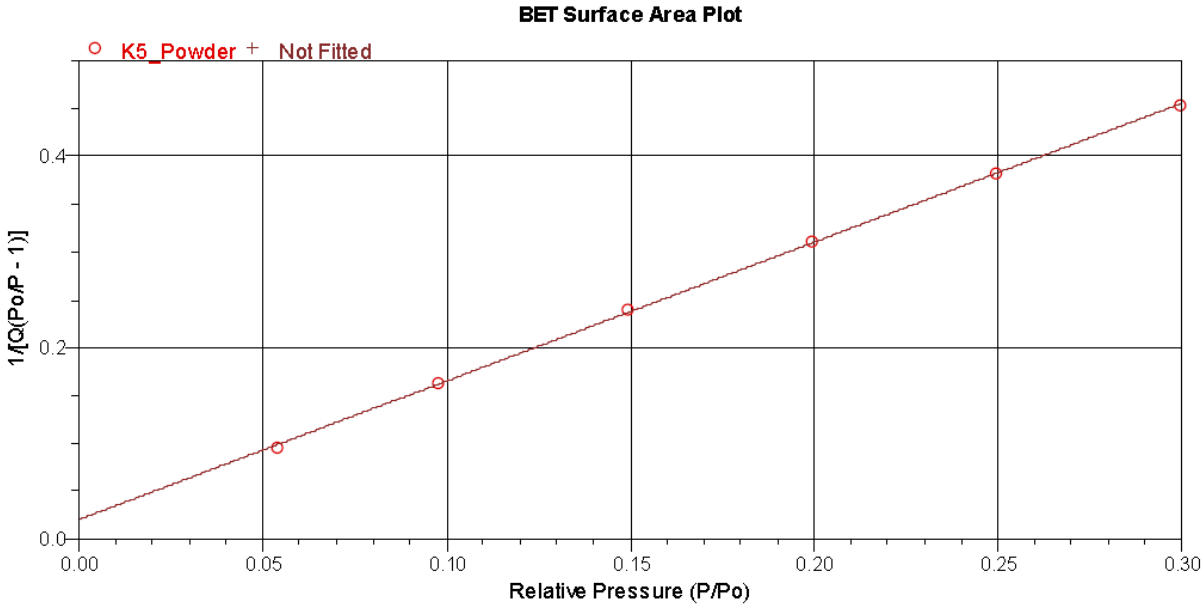
Started: 08.05.2018 12:39:21
Completed: 08.05.2018 14:01:14
Report Time: 08.05.2018 14:01:59
Sample Mass: 2,0683 g
Cold Free Space: 27,0551 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3201 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.9583 ± 0.0177 m²/g
Slope: 1.451180 ± 0.008625 g/cm³ STP
Y-Intercept: 0.020134 ± 0.001676 g/cm³ STP
C: 73.077873
Qm: 0,6797 cm³/g STP
Correlation Coefficient: 0.9999294
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054142639	0.5937	0.096408
0.097910337	0.6653	0.163137
0.149431369	0.7357	0.238790
0.199565810	0.8018	0.310937
0.249503897	0.8704	0.381960
0.299604821	0.9432	0.453538



Liège

Sample: L1_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\L1_Powder.SMP

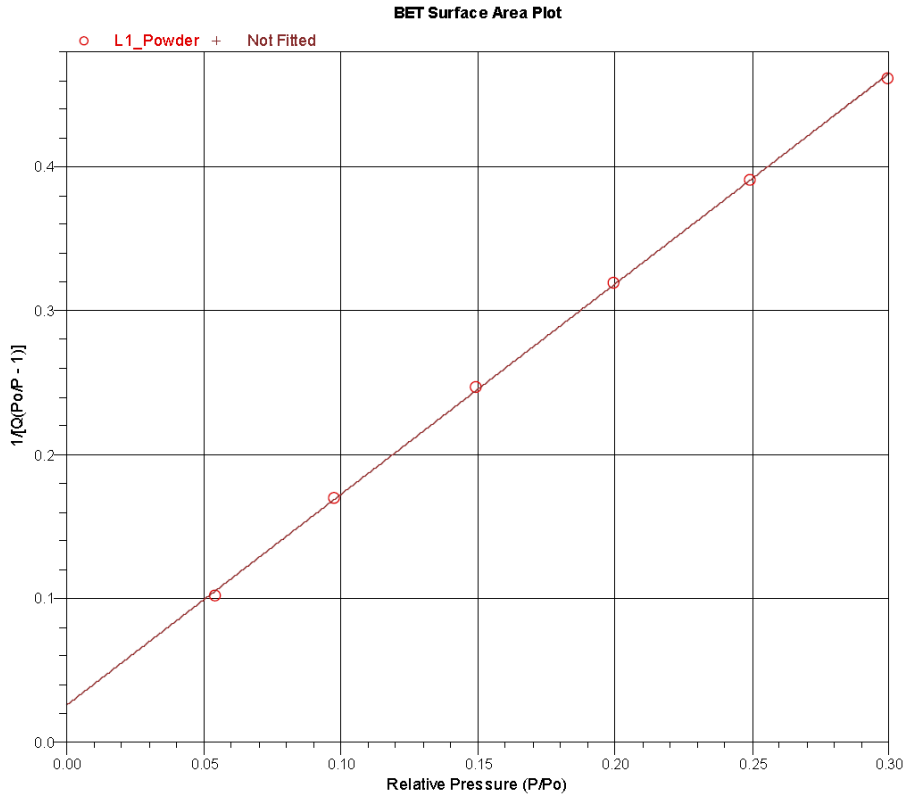
Started: 09.03.2018 17:54:36
Completed: 09.03.2018 19:14:16
Report Time: 09.03.2018 19:16:39
Sample Mass: 2,0352 g
Cold Free Space: 26,9368 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2798 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.9237 ± 0.0251 m²/g
Slope: 1.462860 ± 0.012558 g/cm³ STP
Y-Intercept: 0.025883 ± 0.002440 g/cm³ STP
C: 57.518728
Qm: 0,6717 cm³/g STP
Correlation Coefficient: 0.9998527
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054277408	0.5627	0.101987
0.097705172	0.6368	0.170034
0.149371108	0.7110	0.246985
0.199372322	0.7798	0.319330
0.249427897	0.8508	0.390615
0.299468530	0.9257	0.461796



Sample: L2_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\L2_Powder.SMP

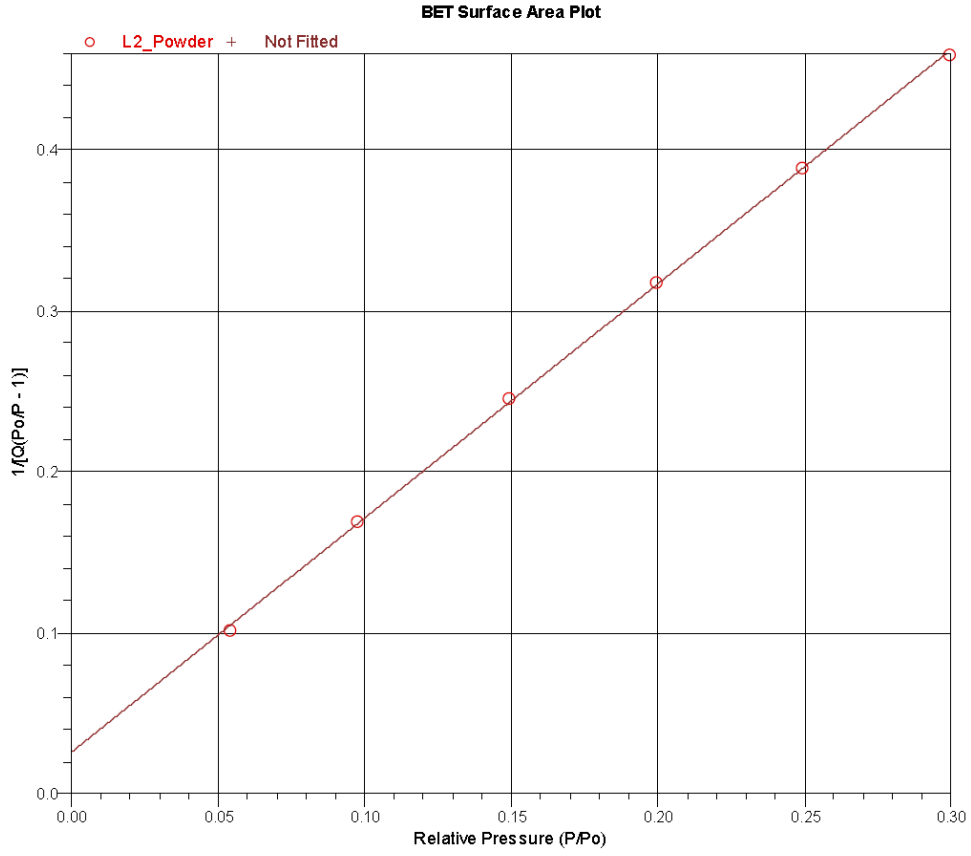
Started: 09.03.2018 17:54:36
Completed: 09.03.2018 19:14:16
Report Time: 09.03.2018 19:16:50
Sample Mass: 2,0661 g
Cold Free Space: 27,0661 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2908 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.9379 ± 0.0246 m²/g
Slope: 1.455900 ± 0.012185 g/cm³ STP
Y-Intercept: 0.025606 ± 0.002367 g/cm³ STP
C: 57.858847
Qm: 0,6750 cm³/g STP
Correlation Coefficient: 0.9998599
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054145633	0.5654	0.101246
0.097622550	0.6405	0.168898
0.149368677	0.7149	0.245611
0.199382664	0.7841	0.317608
0.249432654	0.8551	0.388642
0.299416195	0.9303	0.459404



Sample: L3_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\L3_Powder.SMP

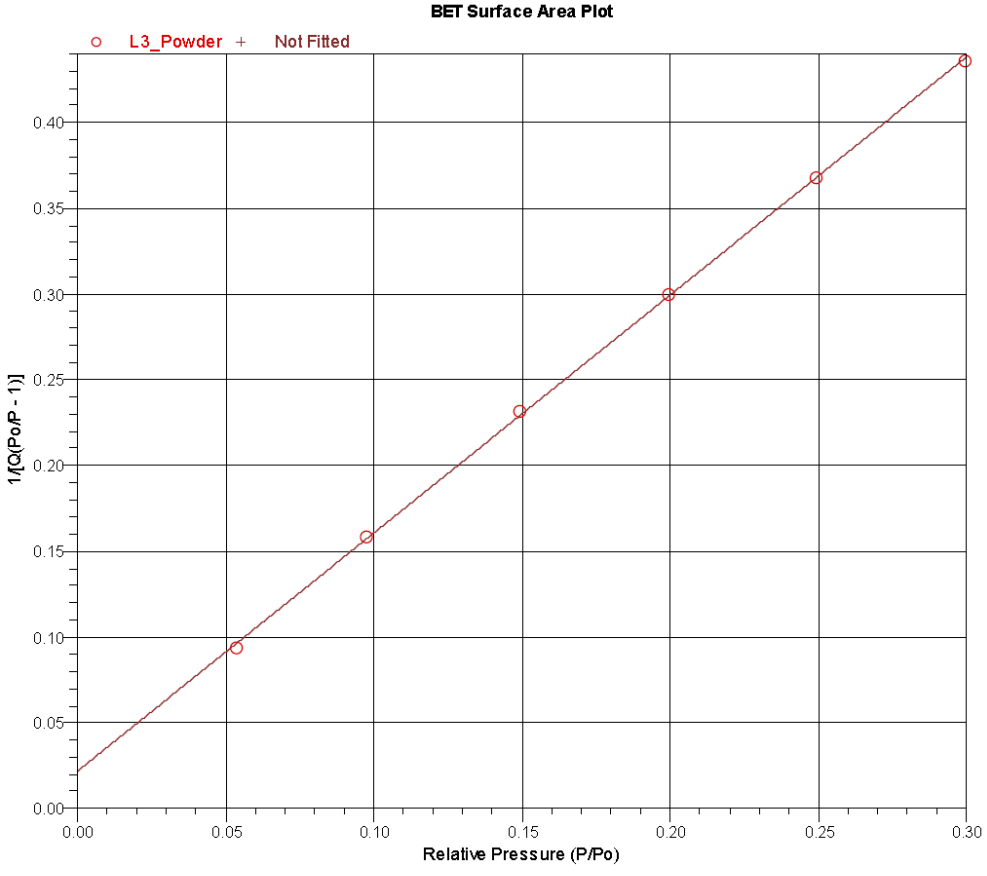
Started: 10.03.2018 11:54:58
Completed: 10.03.2018 13:16:07
Report Time: 10.03.2018 13:16:21
Sample Mass: 2,0607 g
Cold Free Space: 26,8608 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2598 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.0867 ± 0.0217 m²/g
Slope: 1.388426 ± 0.009711 g/cm³ STP
Y-Intercept: 0.021670 ± 0.001887 g/cm³ STP
C: 65.071017
Qm: 0,7092 cm³/g STP
Correlation Coefficient: 0.9999022
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.053902742	0.6064	0.093950
0.097652815	0.6840	0.158221
0.149389864	0.7599	0.231121
0.199448844	0.8307	0.299932
0.249453450	0.9034	0.367892
0.299527257	0.9810	0.435882



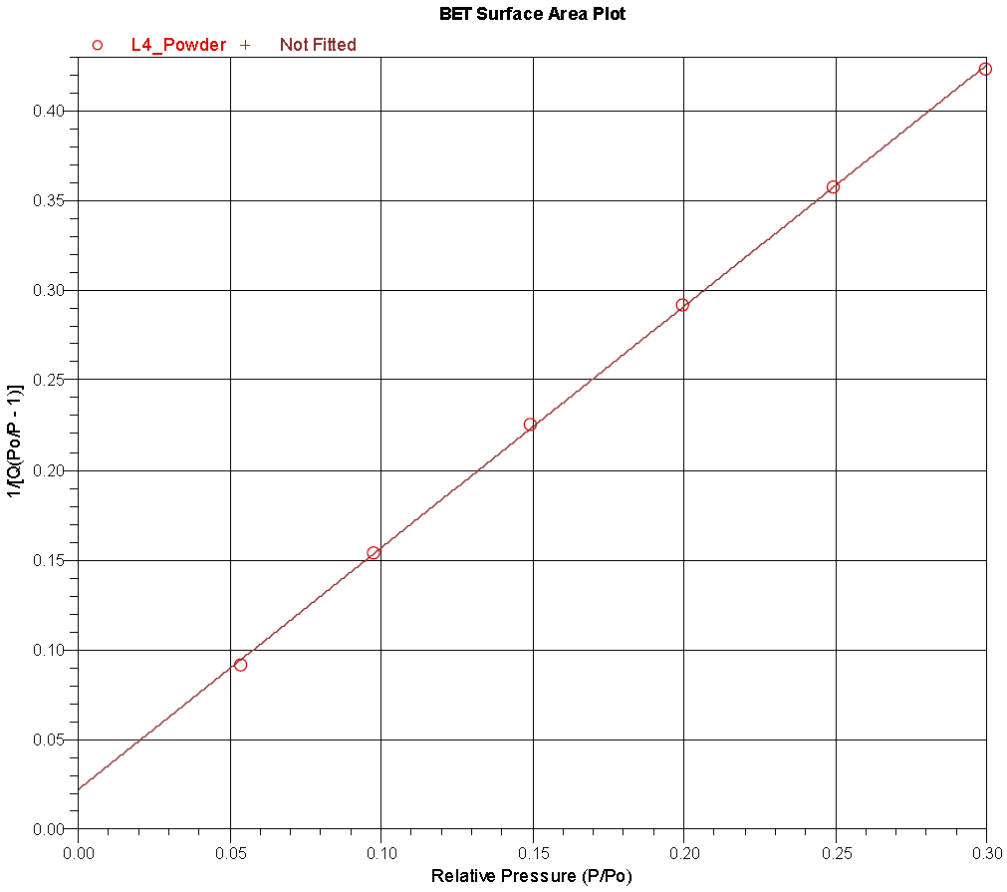
Sample: L4_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\L4_Powder.SMP

Started:	10.03.2018 11:54:58	Analysis Adsorptive:	N2
Completed:	10.03.2018 13:16:07	Analysis Bath Temp.:	-195,850 °C
Report Time:	10.03.2018 13:16:32	Thermal Correction:	No
Sample Mass:	2,1296 g	Warm Free Space:	9,3318 cm³ Measured
Cold Free Space:	26,9533 cm³	Equilibration Interval:	10 s
Low Pressure Dose:	None	Sample Density:	1,000 g/cm³
Automatic Degas:	No		

BET Report

BET Surface Area: 3.1822 ± 0.0241 m²/g
Slope: 1.345818 ± 0.010170 g/cm³ STP
Y-Intercept: 0.021992 ± 0.001975 g/cm³ STP
C: 62.194910
Qm: 0,7311 cm³/g STP
Correlation Coefficient: 0.9998858
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.053524281	0.6192	0.091331
0.097482530	0.7003	0.154233
0.149335856	0.7799	0.225105
0.199429524	0.8537	0.291793
0.249441168	0.9296	0.357505
0.299525384	1.0099	0.423399



Sample: L5_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\L5_Powder.SMP

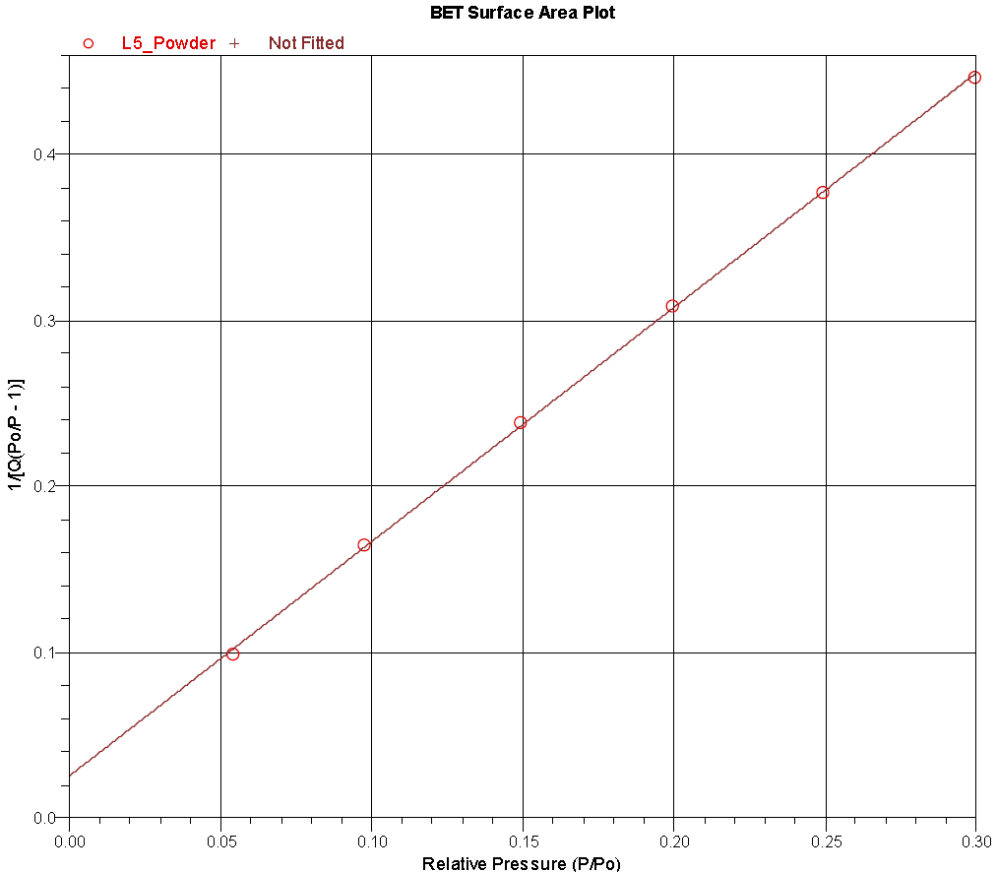
Started: 10.03.2018 11:54:58
Completed: 10.03.2018 13:16:08
Report Time: 10.03.2018 13:16:43
Sample Mass: 2,0400 g
Cold Free Space: 27,2393 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3754 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.0251 ± 0.0258 m²/g
Slope: 1.413659 ± 0.012031 g/cm³ STP
Y-Intercept: 0.025182 ± 0.002338 g/cm³ STP
C: 57.137611
Qm: 0,6950 cm³/g STP
Correlation Coefficient: 0.9998552
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054235321	0.5810	0.098697
0.097660651	0.6583	0.164406
0.149400498	0.7353	0.238865
0.199415199	0.8066	0.308820
0.249462046	0.8800	0.377691
0.299535500	0.9576	0.446544



Mons, limit Obourg Nouvelles

Sample: MON1_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MON1_Powder.SMP

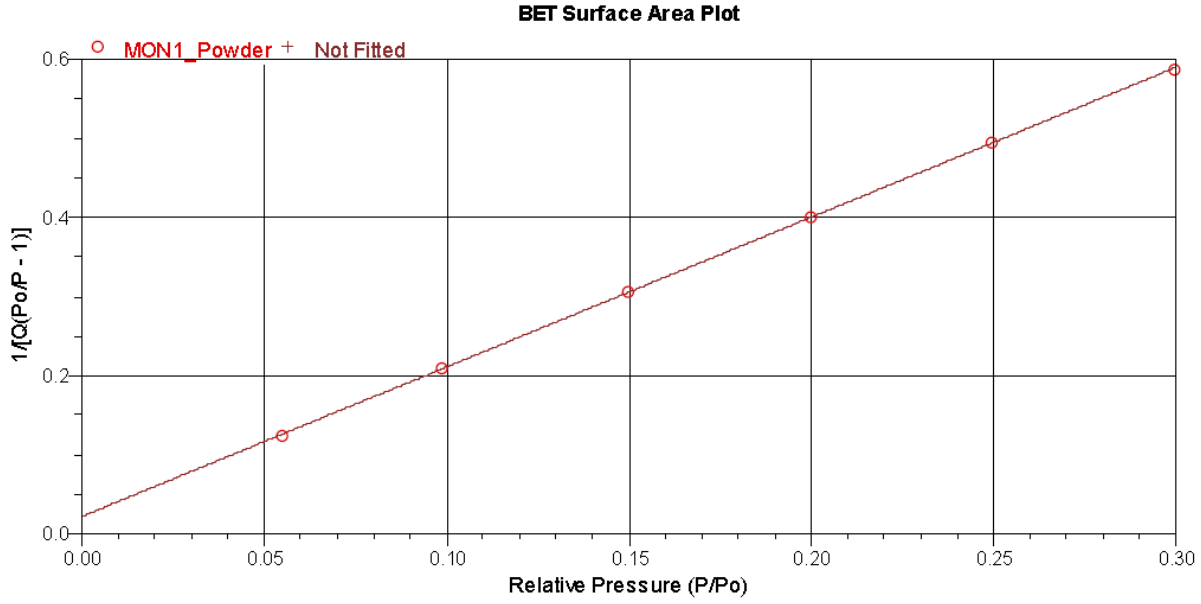
Started: 05.02.2018 15:32:49
Completed: 05.02.2018 16:55:43
Report Time: 05.02.2018 16:58:15
Sample Mass: 2,2343 g
Cold Free Space: 26,7256 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2690 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.2727 ± 0.0110 m²/g
Slope: 1.893642 ± 0.009137 g/cm³ STP
Y-Intercept: 0.021511 ± 0.001777 g/cm³ STP
C: 89.030409
Qm: 0,5222 cm³/g STP
Correlation Coefficient: 0.9999534
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055040634	0.4722	0.123359
0.098463652	0.5230	0.208819
0.149573251	0.5736	0.306630
0.199628297	0.6222	0.400854
0.249630578	0.6732	0.494151
0.299665448	0.7285	0.587370



Sample: MON2_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MON2_Powder.SMP

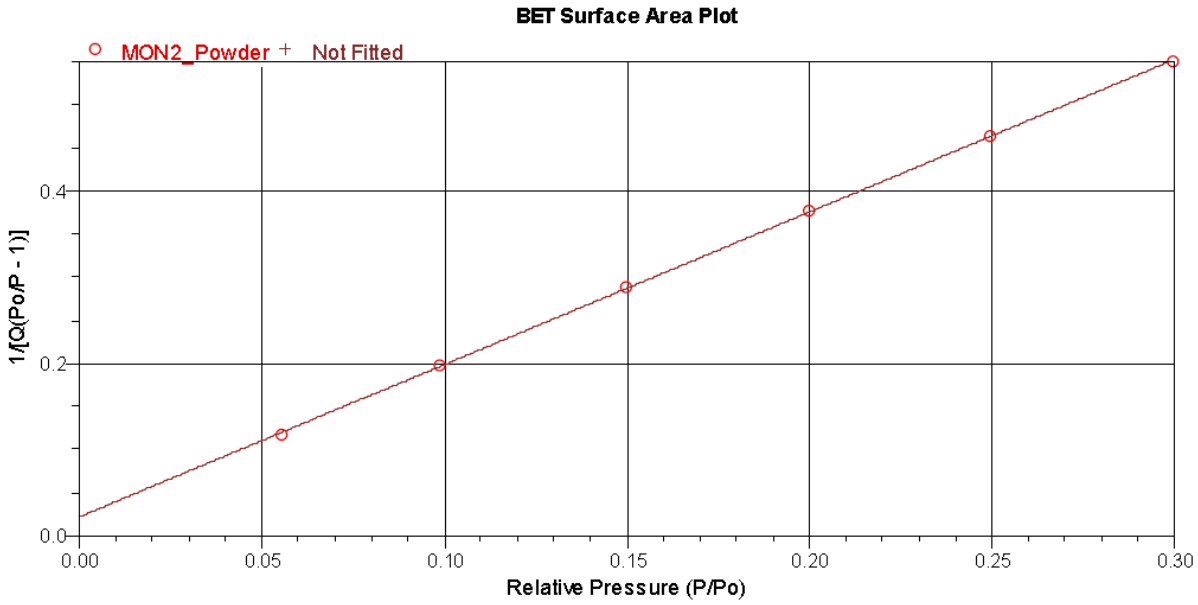
Started: 05.02.2018 15:32:49
Completed: 05.02.2018 16:55:44
Report Time: 05.02.2018 16:57:55
Sample Mass: 2,0269 g
Cold Free Space: 26,6554 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2047 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.4313 ± 0.0146 m²/g
Slope: 1.768245 ± 0.010563 g/cm³ STP
Y-Intercept: 0.021952 ± 0.002055 g/cm³ STP
C: 81.550239
Qm: 0,5586 cm³/g STP
Correlation Coefficient: 0.9999286
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055309593	0.5002	0.117058
0.098527850	0.5547	0.197053
0.149641782	0.6096	0.288675
0.199631762	0.6624	0.376559
0.249619796	0.7179	0.463395
0.299736472	0.7783	0.549993



Sample: MON3_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MON3_Powder.SMP

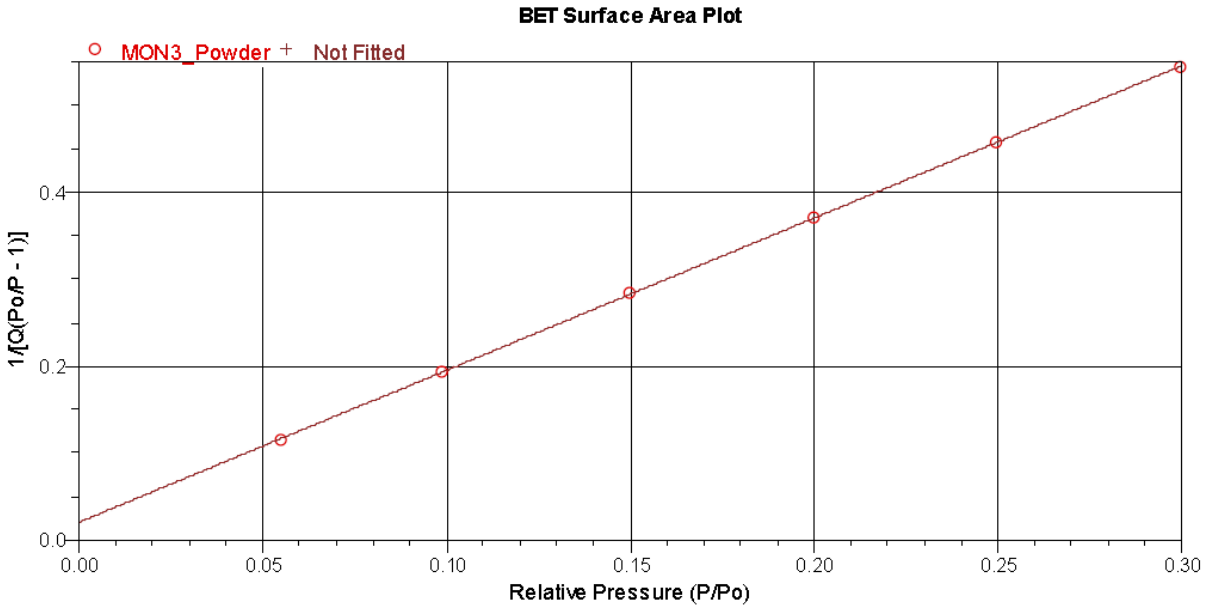
Started: 05.02.2018 15:32:49
Completed: 05.02.2018 16:55:44
Report Time: 05.02.2018 16:58:06
Sample Mass: 2,0754 g
Cold Free Space: 27,0339 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3218 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.4592 ± 0.0125 m²/g
Slope: 1.749476 ± 0.008839 g/cm³ STP
Y-Intercept: 0.020443 ± 0.001720 g/cm³ STP
C: 86.577287
Qm: 0,5650 cm³/g STP
Correlation Coefficient: 0.9999490
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055051174	0.5091	0.114443
0.098464652	0.5643	0.193547
0.149612932	0.6194	0.284019
0.199649446	0.6724	0.370993
0.249645762	0.7279	0.457076
0.299730811	0.7878	0.543301



Sample: MON4_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MON4_Powder.SMP

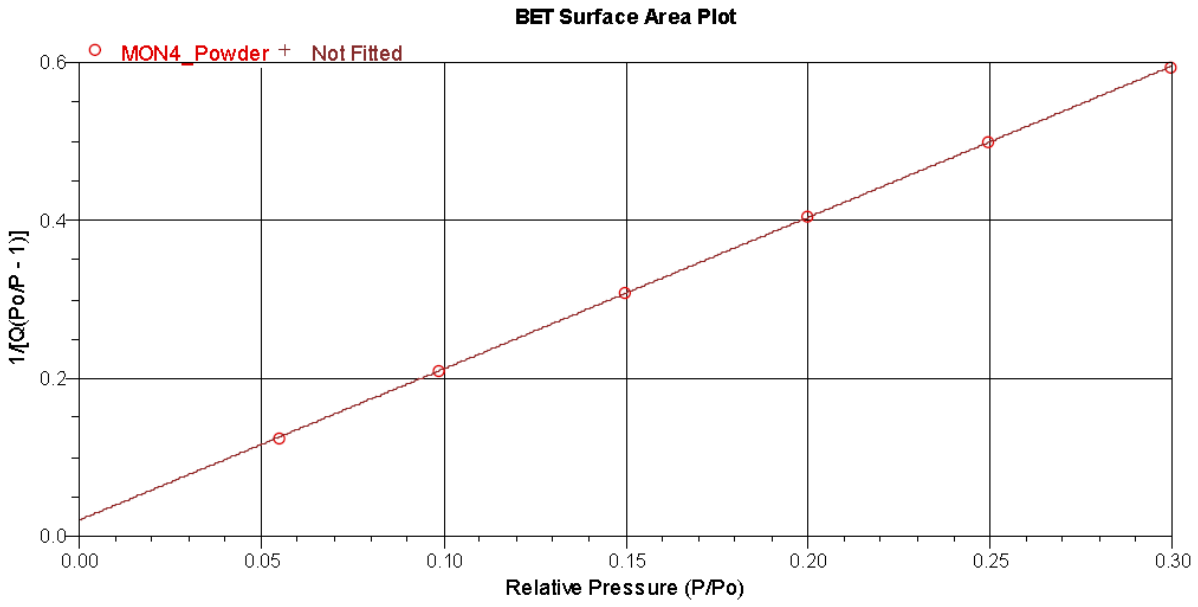
Started: 05.02.2018 17:08:39
Completed: 05.02.2018 18:37:14
Report Time: 05.02.2018 18:39:14
Sample Mass: 2,2227 g
Cold Free Space: 26,4449 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,1613 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.2457 ± 0.0088 m²/g
Slope: 1.918217 ± 0.007441 g/cm³ STP
Y-Intercept: 0.019934 ± 0.001448 g/cm³ STP
C: 97.227708
Qm: 0,5160 cm³/g STP
Correlation Coefficient: 0.9999699
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055123638	0.4716	0.123702
0.098538497	0.5212	0.209713
0.149629704	0.5703	0.308563
0.199664061	0.6176	0.403917
0.249664295	0.6673	0.498640
0.299726661	0.7209	0.593701



Sample: MON5_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MON5_Powder.SMP

Started: 05.02.2018 17:08:39
Completed: 05.02.2018 18:37:14
Report Time: 05.02.2018 18:39:26
Sample Mass: 2,0351 g
Cold Free Space: 26,0756 cm³
Low Pressure Dose: None
Automatic Degas: No

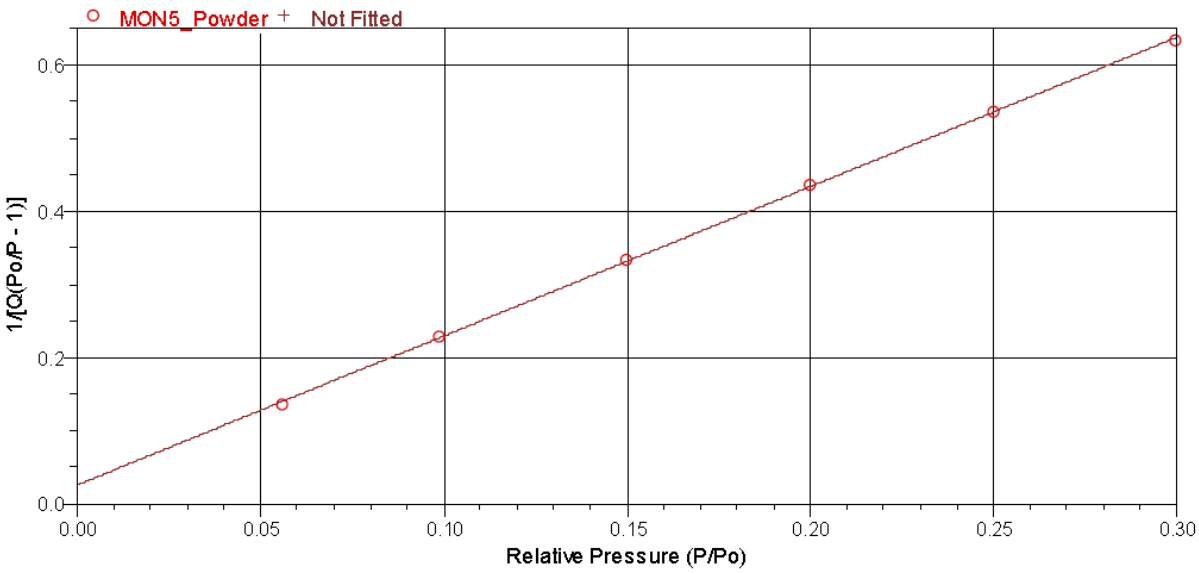
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,0859 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.1095 ± 0.0143 m²/g
Slope: 2.037155 ± 0.013747 g/cm³ STP
Y-Intercept: 0.026159 ± 0.002676 g/cm³ STP
C: 78.876097
Qm: 0,4847 cm³/g STP
Correlation Coefficient: 0.9999089
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055704155	0.4329	0.136252
0.098701679	0.4801	0.228110
0.149699527	0.5273	0.333906
0.199682626	0.5733	0.435232
0.249703168	0.6222	0.534890
0.299691779	0.6749	0.634062

BET Surface Area Plot



Mons, Obourg St. Vaast

Sample: MOV1_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MOV1_Powder.SMP

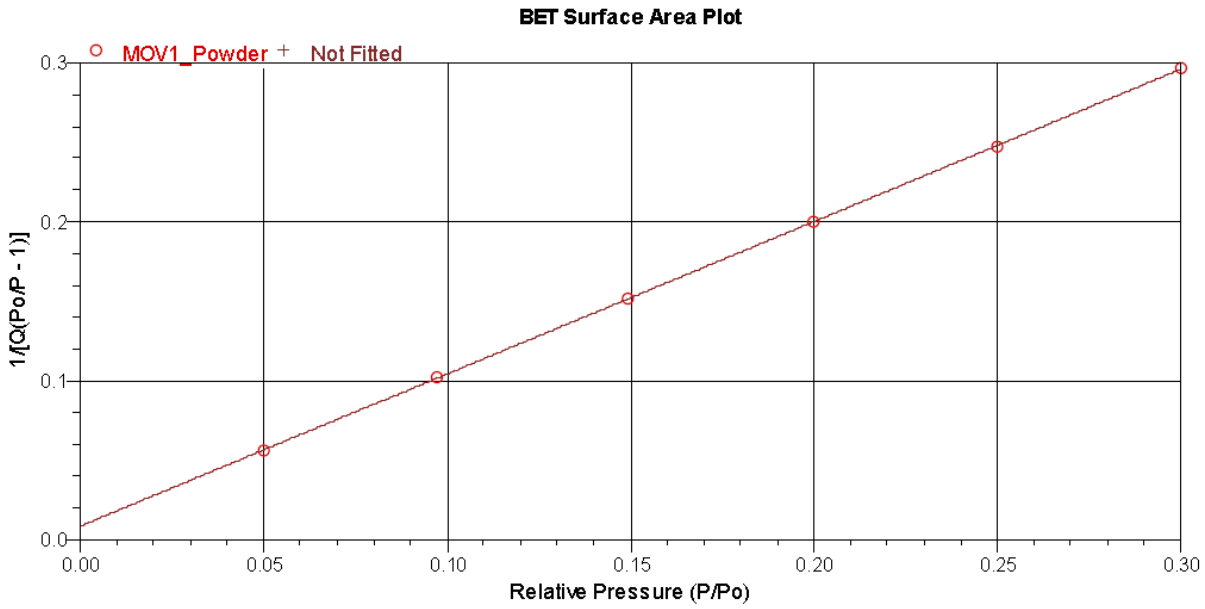
Started: 05.02.2018 17:08:39
Completed: 05.02.2018 18:37:15
Report Time: 05.02.2018 18:39:40
Sample Mass: 2,0409 g
Cold Free Space: 27,3700 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3761 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 4.5022 ± 0.0110 m²/g
Slope: 0.958246 ± 0.002310 g/cm³ STP
Y-Intercept: 0.008510 ± 0.000449 g/cm³ STP
C: 113.598744
Qm: 1,0344 cm³/g STP
Correlation Coefficient: 0.9999884
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.050142147	0.9408	0.056114
0.097175309	1.0534	0.102182
0.149465992	1.1559	0.152033
0.199674641	1.2498	0.199624
0.249735114	1.3457	0.247351
0.299960173	1.4465	0.296230



Sample: MOV2_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MOV2_Powder.SMP

Started: 06.02.2018 14:21:25
Completed: 06.02.2018 15:52:35
Report Time: 06.02.2018 15:53:29
Sample Mass: 2,0696 g
Cold Free Space: 26,8556 cm³
Low Pressure Dose: None
Automatic Degas: No

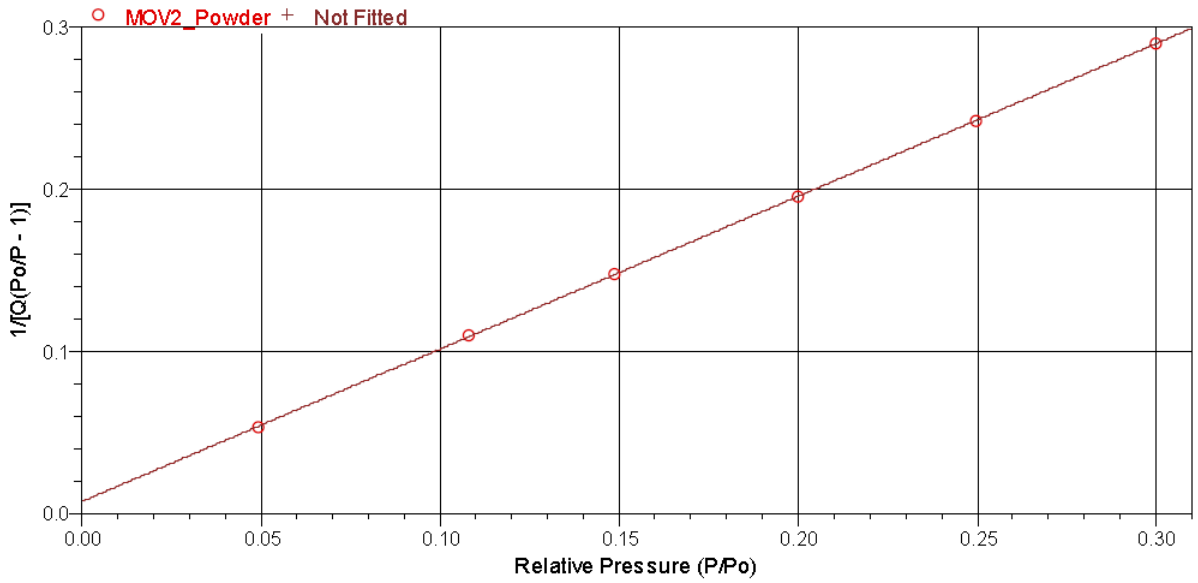
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2786 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 4.5871 ± 0.0114 m²/g
Slope: 0.941382 ± 0.002310 g/cm³ STP
Y-Intercept: 0.007482 ± 0.000451 g/cm³ STP
C: 126.820033
Qm: 1,0539 cm³/g STP
Correlation Coefficient: 0.9999880
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.049297942	0.9656	0.053702
0.108213648	1.1048	0.109837
0.148686592	1.1834	0.147584
0.199764471	1.2793	0.195125
0.249934188	1.3753	0.242279
0.300148812	1.4763	0.290506

BET Surface Area Plot



Sample: MOV3_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MOV3_Powder.SMP

Started: 06.02.2018 14:21:25
Completed: 06.02.2018 15:52:35
Report Time: 06.02.2018 15:53:56
Sample Mass: 2,0634 g
Cold Free Space: 26,9279 cm³
Low Pressure Dose: None
Automatic Degas: No

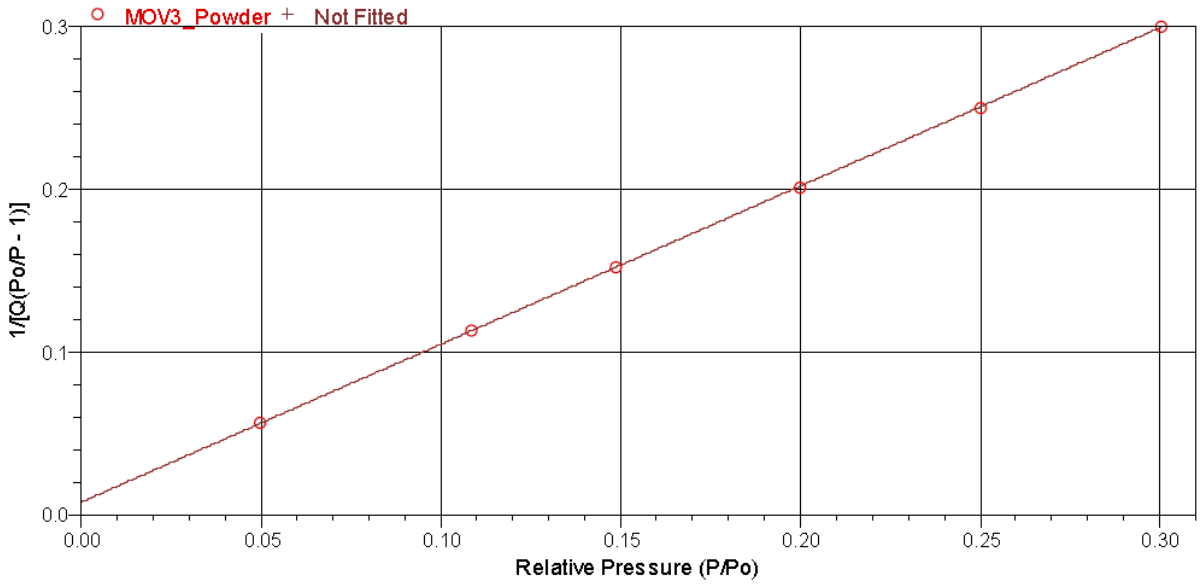
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3227 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 4.4450 ± 0.0114 m²/g
Slope: 0.971337 ± 0.002464 g/cm³ STP
Y-Intercept: 0.007873 ± 0.000481 g/cm³ STP
C: 124.381444
Qm: 1,0212 cm³/g STP
Correlation Coefficient: 0.9999871
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.049981517	0.9361	0.056201
0.108526428	1.0696	0.113817
0.148775399	1.1459	0.152525
0.199842792	1.2390	0.201581
0.249988603	1.3324	0.250163
0.300209154	1.4302	0.299966

BET Surface Area Plot



Sample: MOV4_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MOV4_Powder.SMP

Started: 06.02.2018 14:21:25
Completed: 06.02.2018 15:52:36
Report Time: 06.02.2018 15:53:10
Sample Mass: 2,0422 g
Cold Free Space: 27,0119 cm³
Low Pressure Dose: None
Automatic Degas: No

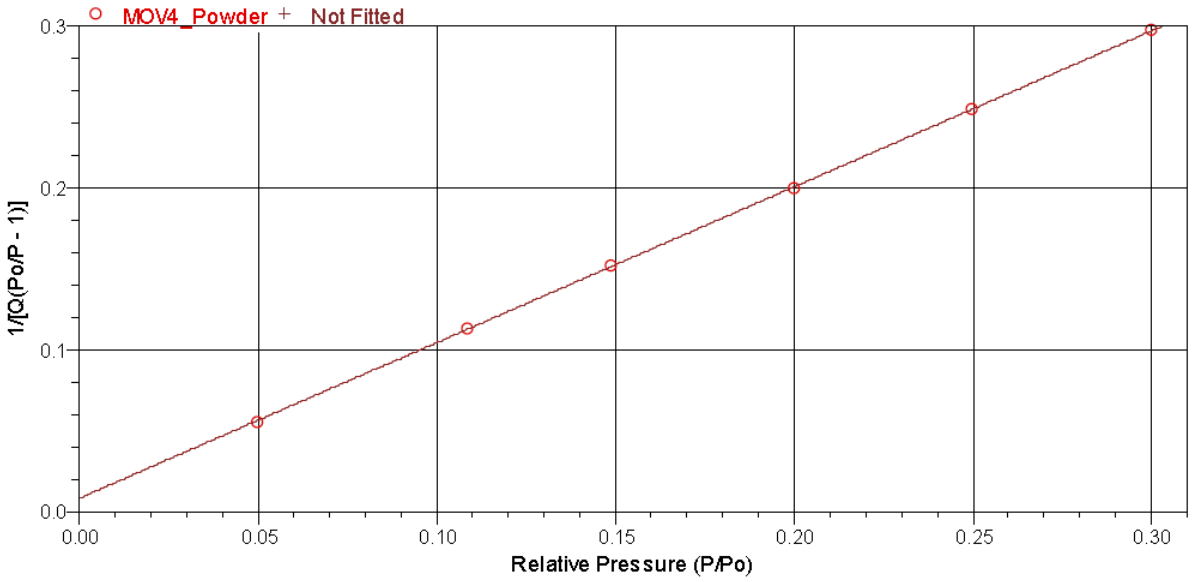
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2946 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 4.4864 ± 0.0108 m²/g
Slope: 0.961696 ± 0.002294 g/cm³ STP
Y-Intercept: 0.008477 ± 0.000448 g/cm³ STP
C: 114.453937
Qm: 1,0307 cm³/g STP
Correlation Coefficient: 0.9999886
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.049823584	0.9370	0.055964
0.108447011	1.0733	0.113336
0.148721116	1.1510	0.151786
0.199822443	1.2460	0.200424
0.249920827	1.3415	0.248373
0.300134467	1.4422	0.297362

BET Surface Area Plot



Sample: MOV5_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MOV5_Powder.SMP

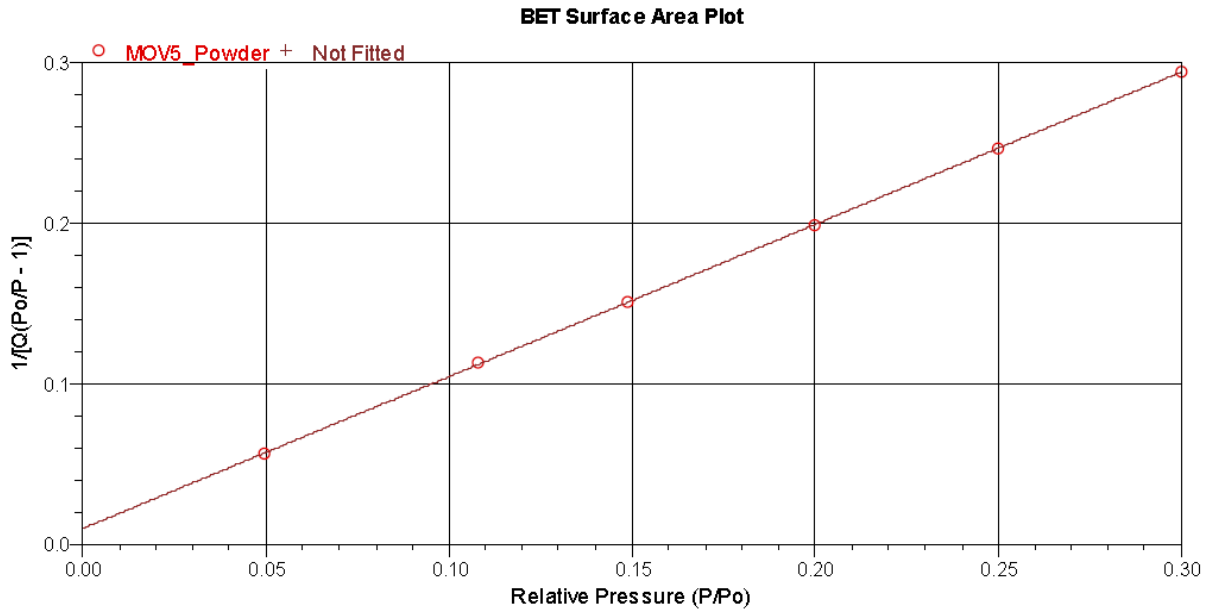
Started: 06.02.2018 16:03:33
Completed: 06.02.2018 17:31:42
Report Time: 06.02.2018 17:33:33
Sample Mass: 2,0518 g
Cold Free Space: 26,6117 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2127 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 4.5434 ± 0.0151 m²/g
Slope: 0.948156 ± 0.003118 g/cm³ STP
Y-Intercept: 0.009838 ± 0.000609 g/cm³ STP
C: 97.372679
Qm: 1,0438 cm³/g STP
Correlation Coefficient: 0.9999784
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.049680786	0.9312	0.056142
0.108089251	1.0720	0.113048
0.148568177	1.1535	0.151272
0.199744676	1.2531	0.199193
0.249794826	1.3520	0.246271
0.299999633	1.4565	0.294242



Mons, Spiennes

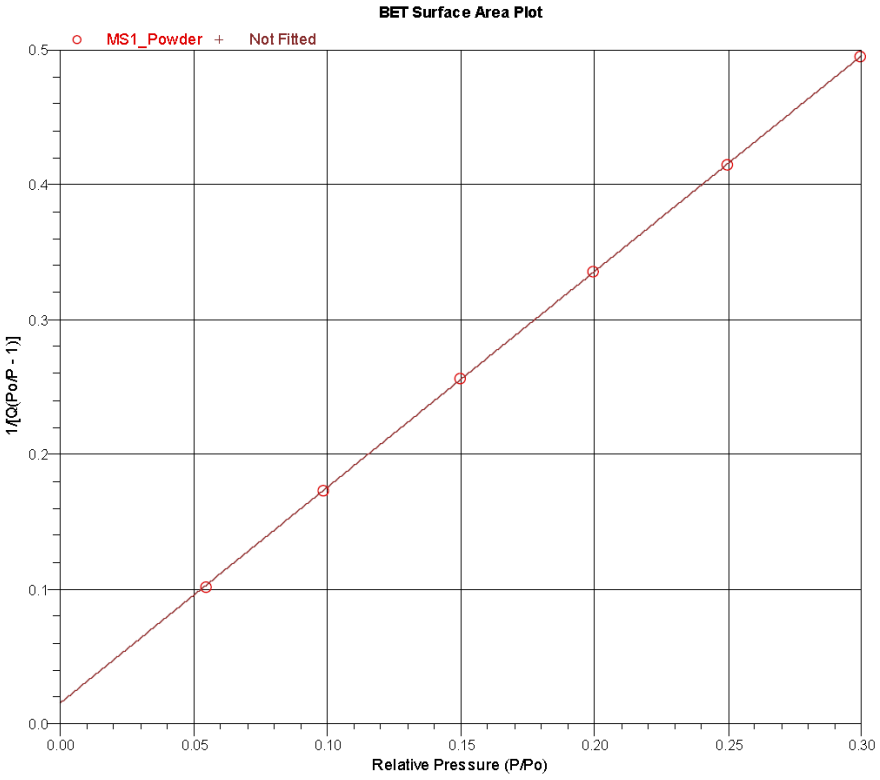
Sample: MS1_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MS1_Powder.SMP

Started:	21.02.2018 15:38:12	Analysis Adsorptive:	N2
Completed:	21.02.2018 17:00:48	Analysis Bath Temp.:	-195,850 °C
Report Time:	21.02.2018 17:01:38	Thermal Correction:	No
Sample Mass:	2,0454 g	Warm Free Space:	9,1570 cm³ Measured
Cold Free Space:	26,5453 cm³	Equilibration Interval:	10 s
Low Pressure Dose:	None	Sample Density:	1,000 g/cm³
Automatic Degas:	No		

BET Report

BET Surface Area: 2.6921 ± 0.0089 m²/g
Slope: 1.601318 ± 0.005255 g/cm³ STP
Y-Intercept: 0.015450 ± 0.001022 g/cm³ STP
C: 104.647548
Qm: 0,6185 cm³/g STP
Correlation Coefficient: 0.9999785
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054506511	0.5690	0.101319
0.098348044	0.6285	0.173539
0.149621402	0.6869	0.256164
0.199623803	0.7427	0.335798
0.249643074	0.8018	0.414965
0.299751686	0.8653	0.494690



Sample: MS2_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MS2_Powder.SMP

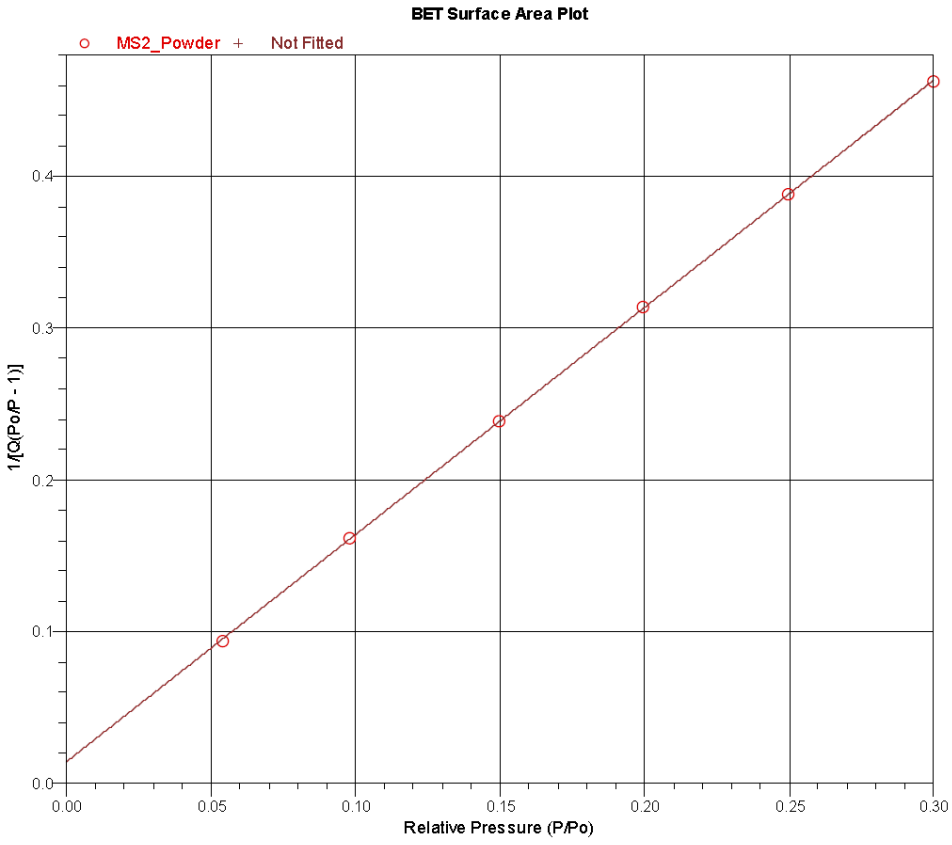
Started: 21.02.2018 15:38:12
Completed: 21.02.2018 17:00:48
Report Time: 21.02.2018 17:01:53
Sample Mass: 2,0581 g
Cold Free Space: 26,0463 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,0665 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.8811 ± 0.0081 m²/g
Slope: 1.496554 ± 0.004161 g/cm³ STP
Y-Intercept: 0.014200 ± 0.000810 g/cm³ STP
C: 106.392616
Qm: 0,6619 cm³/g STP
Correlation Coefficient: 0.9999845
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054212948	0.6086	0.094179
0.098237058	0.6732	0.161826
0.149647116	0.7361	0.239067
0.199684515	0.7961	0.313416
0.249742669	0.8587	0.387670
0.299790321	0.9259	0.462390



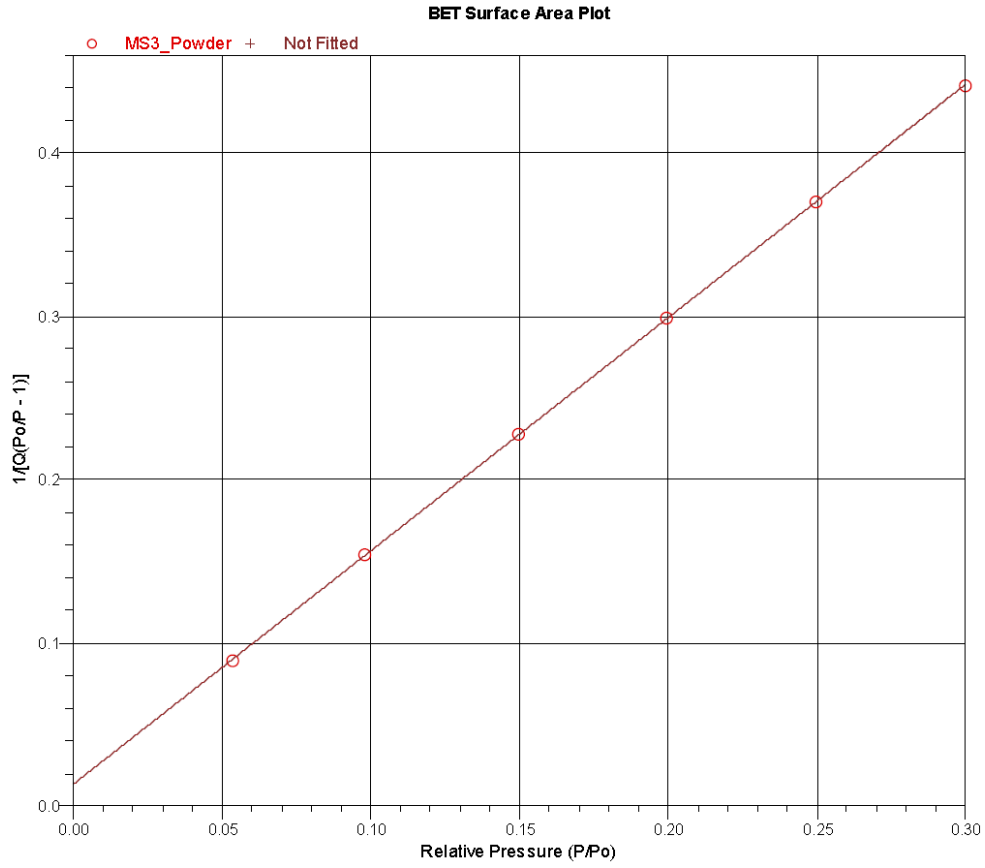
Sample: MS3_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MS3_Powder.SMP

Started:	21.02.2018 15:38:12	Analysis Adsorptive:	N2
Completed:	21.02.2018 17:00:48	Analysis Bath Temp.:	-195,850 °C
Report Time:	21.02.2018 17:02:05	Thermal Correction:	No
Sample Mass:	2,0988 g	Warm Free Space:	9,3964 cm³ Measured
Cold Free Space:	27,4107 cm³	Equilibration Interval:	10 s
Low Pressure Dose:	None	Sample Density:	1,000 g/cm³
Automatic Degas:	No		

BET Report

BET Surface Area: 3.0166 ± 0.0088 m²/g
Slope: 1.429649 ± 0.004140 g/cm³ STP
Y-Intercept: 0.013250 ± 0.000805 g/cm³ STP
C: 108.899015
Qm: 0,6930 cm³/g STP
Correlation Coefficient: 0.9999832
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.053861853	0.6389	0.089109
0.098221708	0.7061	0.154254
0.149615837	0.7715	0.228057
0.199667028	0.8341	0.299105
0.249727885	0.8995	0.370024
0.299779490	0.9701	0.441331



Sample: MS4_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MS4_Powder.SMP

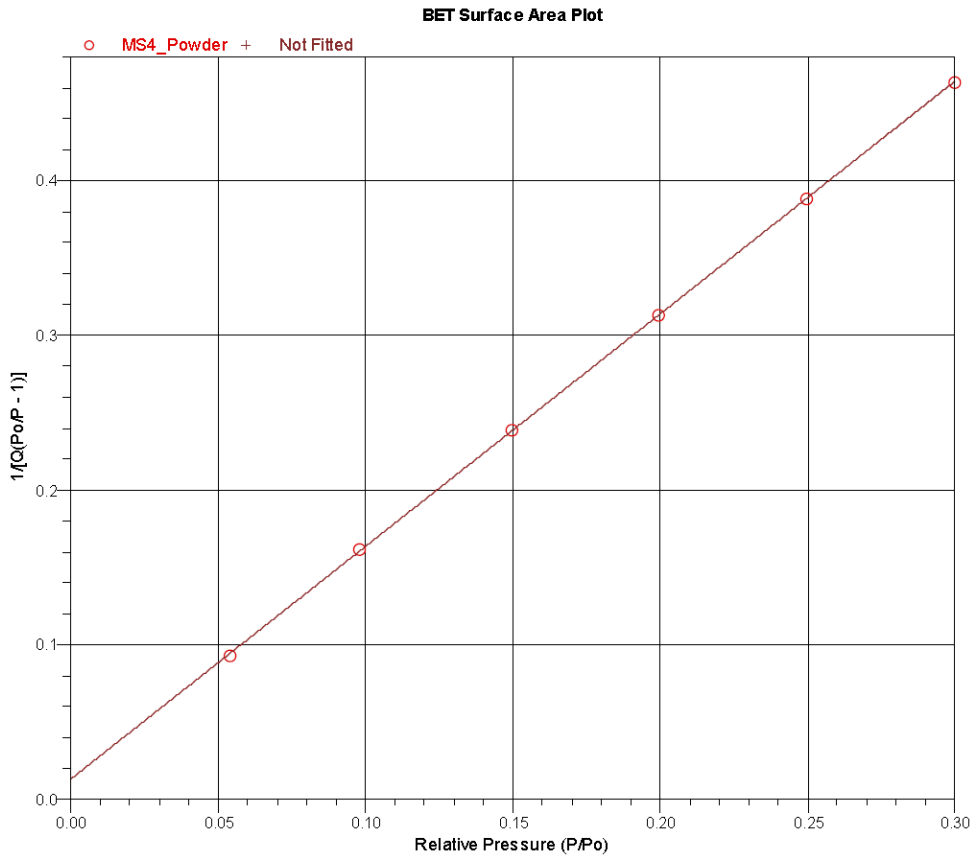
Started: 06.03.2018 13:39:33
Completed: 06.03.2018 15:00:19
Report Time: 06.03.2018 15:01:16
Sample Mass: 2,0892 g
Cold Free Space: 27,0793 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3270 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.8705 ± 0.0066 m²/g
Slope: 1.503234 ± 0.003414 g/cm³ STP
Y-Intercept: 0.013104 ± 0.000664 g/cm³ STP
C: 115.718524
Qm: 0,6595 cm³/g STP
Correlation Coefficient: 0.9999897
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.053935401	0.6114	0.093239
0.098219939	0.6751	0.161344
0.149598638	0.7368	0.238741
0.199590806	0.7959	0.313295
0.249693088	0.8575	0.388104
0.299774722	0.9236	0.463516



Sample: MS5_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MS5_Powder.SMP

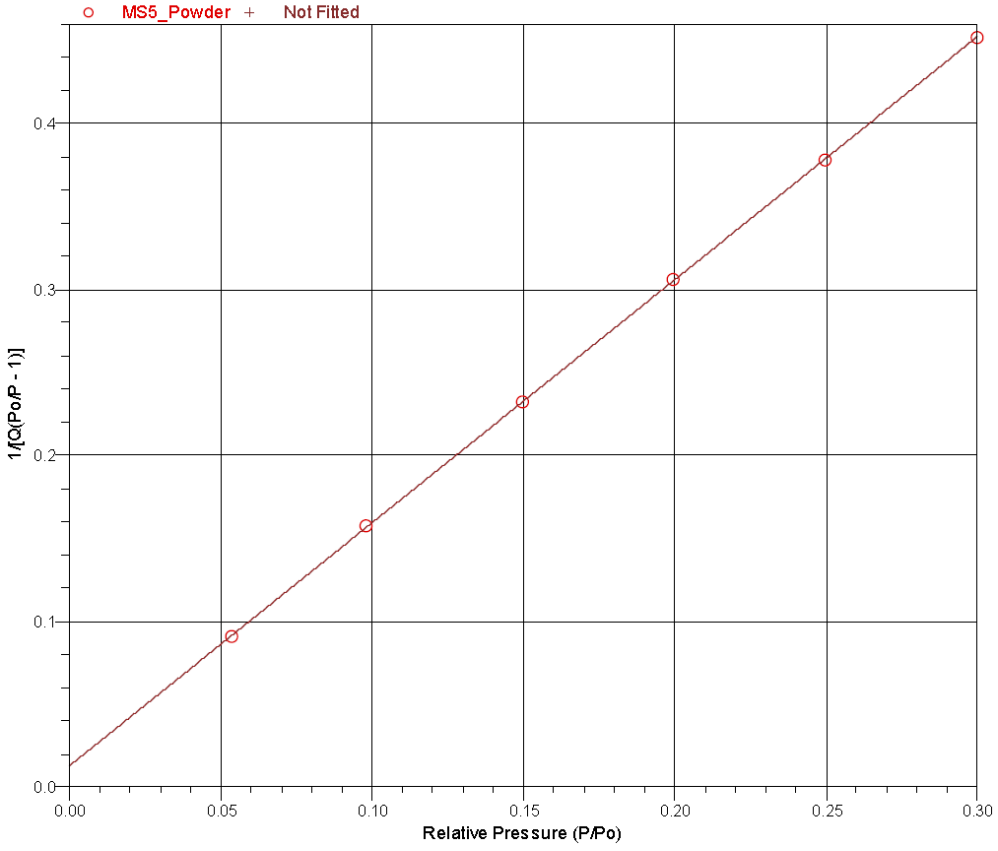
Started:	06.03.2018 13:39:33	Analysis Adsorptive:	N2
Completed:	06.03.2018 15:00:19	Analysis Bath Temp.:	-195,850 °C
Report Time:	06.03.2018 15:01:36	Thermal Correction:	No
Sample Mass:	2,1005 g	Warm Free Space:	9,2455 cm³ Measured
Cold Free Space:	26,8668 cm³	Equilibration Interval:	10 s
Low Pressure Dose:	None	Sample Density:	1,000 g/cm³
Automatic Degas:	No		

BET Report

BET Surface Area: 2.9431 ± 0.0065 m²/g
Slope: 1.466315 ± 0.003186 g/cm³ STP
Y-Intercept: 0.012604 ± 0.000620 g/cm³ STP
C: 117.336203
Qm: 0,6762 cm³/g STP
Correlation Coefficient: 0.9999906
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.053756675	0.6275	0.090534
0.098218961	0.6928	0.157203
0.149581763	0.7563	0.232569
0.199722746	0.8164	0.305701
0.249723556	0.8795	0.378466
0.299910301	0.9475	0.452123

BET Surface Area Plot



Mons, Trivières

Sample: MT1_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MT1_Powder.SMP

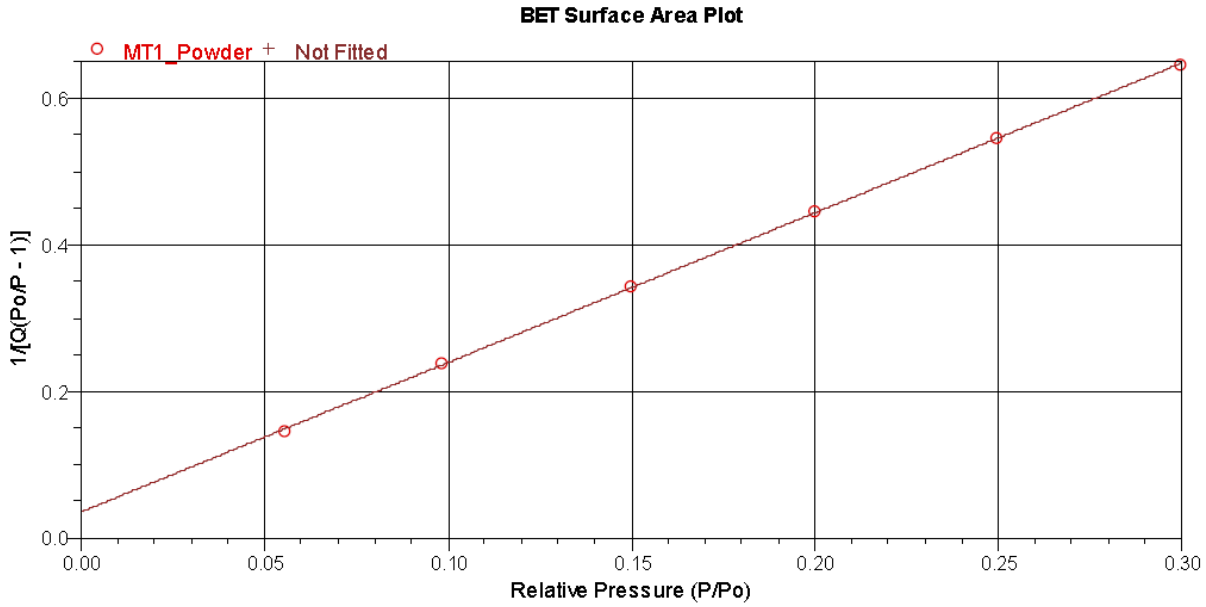
Started: 08.05.2018 12:39:21
Completed: 08.05.2018 14:01:14
Report Time: 08.05.2018 14:02:11
Sample Mass: 2,0811 g
Cold Free Space: 26,1280 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,0105 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.0981 ± 0.0160 m²/g
Slope: 2.038694 ± 0.015564 g/cm³ STP
Y-Intercept: 0.035867 ± 0.003029 g/cm³ STP
C: 57.841129
Qm: 0,4820 cm³/g STP
Correlation Coefficient: 0.9998835
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055650658	0.4055	0.145343
0.098287181	0.4589	0.237541
0.149597761	0.5114	0.343975
0.199719593	0.5603	0.445440
0.249647801	0.6107	0.544823
0.299722596	0.6645	0.644058



Sample: MT2_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MT2_Powder.SMP

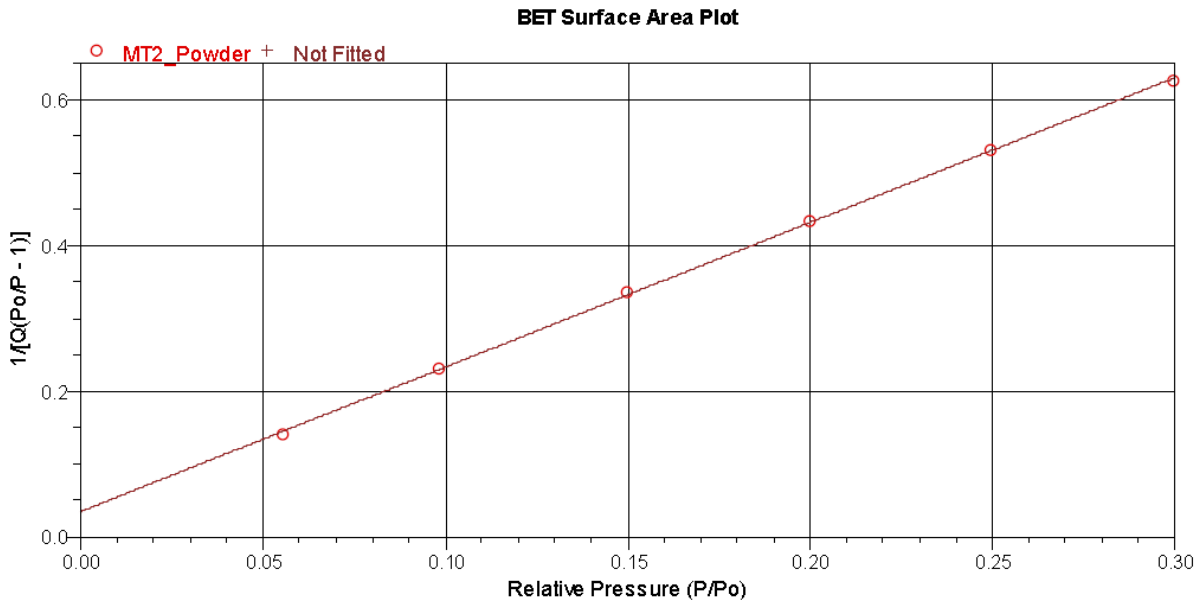
Started: 08.05.2018 12:39:21
Completed: 08.05.2018 14:01:15
Report Time: 08.05.2018 14:02:21
Sample Mass: 2,0816 g
Cold Free Space: 27,1067 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2928 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.1582 ± 0.0175 m²/g
Slope: 1.981488 ± 0.016069 g/cm³ STP
Y-Intercept: 0.035269 ± 0.003126 g/cm³ STP
C: 57.181980
Qm: 0,4958 cm³/g STP
Correlation Coefficient: 0.9998685
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055570754	0.4166	0.141227
0.098339021	0.4710	0.231567
0.149559096	0.5251	0.334892
0.199609847	0.5759	0.433045
0.249667340	0.6277	0.530131
0.299670322	0.6834	0.626102



Sample: MT3_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MT3_Powder.SMP

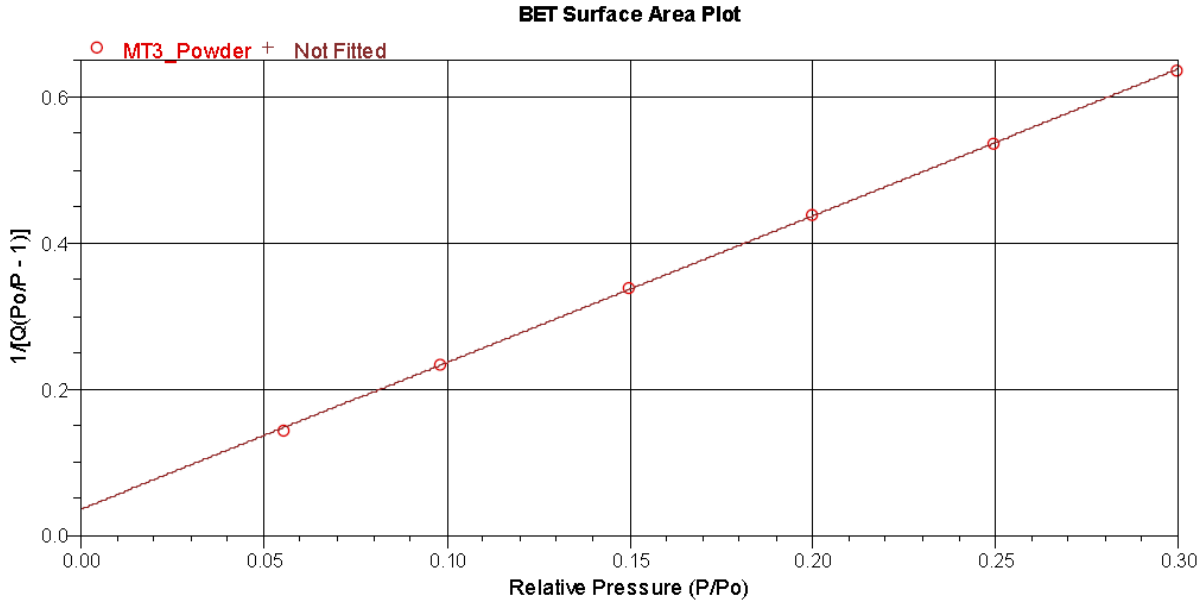
Started: 08.05.2018 14:15:36
Completed: 08.05.2018 15:35:05
Report Time: 08.05.2018 16:10:02
Sample Mass: 2,0723 g
Cold Free Space: 26,5903 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,1845 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.1326 ± 0.0163 m²/g
Slope: 2.004753 ± 0.015271 g/cm³ STP
Y-Intercept: 0.036251 ± 0.002970 g/cm³ STP
C: 56.301612
Qm: 0,4900 cm³/g STP
Correlation Coefficient: 0.9998840
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055574154	0.4094	0.143719
0.098184302	0.4644	0.234427
0.149519870	0.5184	0.339146
0.199616370	0.5686	0.438642
0.249508098	0.6197	0.536448
0.299634901	0.6746	0.634202



Sample: MT4_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MT4_Powder.SMP

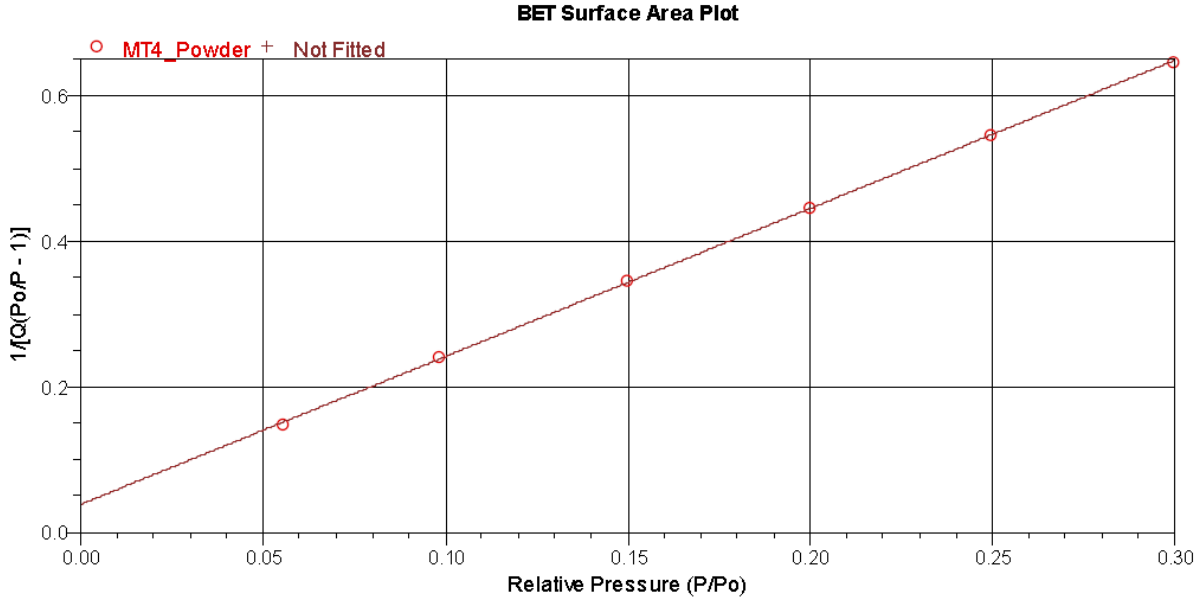
Started: 08.05.2018 14:15:36
Completed: 08.05.2018 15:35:05
Report Time: 08.05.2018 16:10:13
Sample Mass: 2,0609 g
Cold Free Space: 25,9875 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,0341 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.1039 ± 0.0174 m²/g
Slope: 2.029949 ± 0.016757 g/cm³ STP
Y-Intercept: 0.038905 ± 0.003260 g/cm³ STP
C: 53.177439
Qm: 0,4834 cm³/g STP
Correlation Coefficient: 0.9998637
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055654722	0.3995	0.147516
0.098206999	0.4541	0.239843
0.149550322	0.5085	0.345824
0.199595282	0.5585	0.446518
0.249655309	0.6097	0.545698
0.299660973	0.6642	0.644193



Sample: MT5_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MT5_Powder.SMP

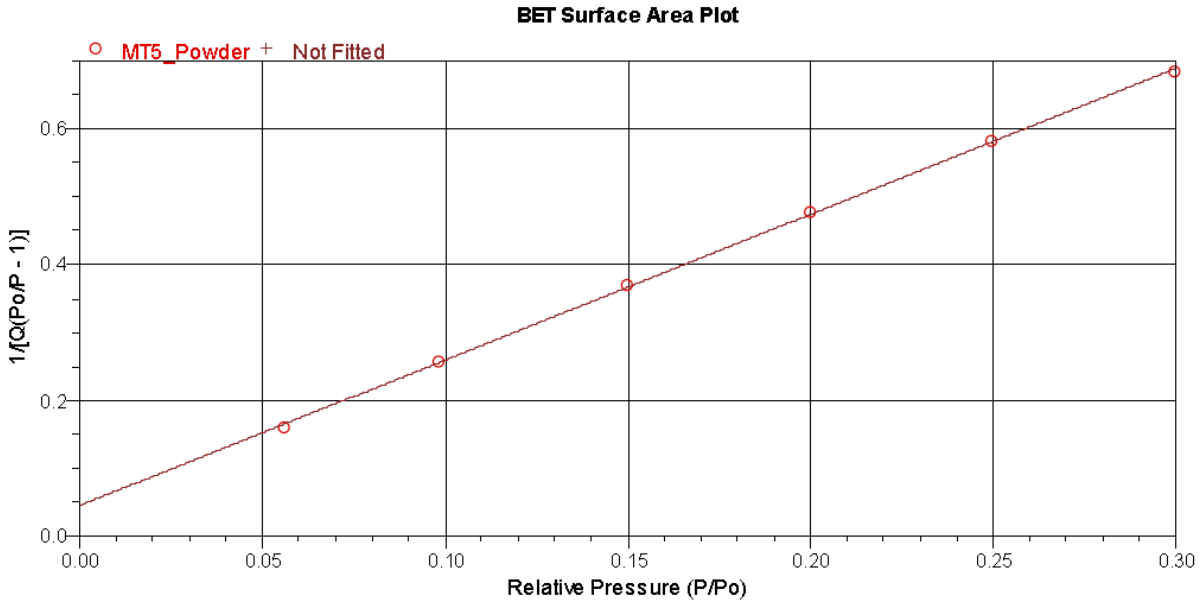
Started: 08.05.2018 14:15:36
Completed: 08.05.2018 15:35:05
Report Time: 08.05.2018 16:10:22
Sample Mass: 2,0476 g
Cold Free Space: 27,6026 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,4337 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.9851 ± 0.0192 m²/g
Slope: 2.148142 ± 0.020834 g/cm³ STP
Y-Intercept: 0.044432 ± 0.004053 g/cm³ STP
C: 49.346251
Qm: 0,4561 cm³/g STP
Correlation Coefficient: 0.9998119
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055889594	0.3719	0.159177
0.098378376	0.4237	0.257505
0.149533181	0.4755	0.369751
0.199615599	0.5234	0.476455
0.249586536	0.5727	0.580726
0.299630962	0.6253	0.684189



Stevns Klint

Sample: SK1_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\SK1_Powder.SMP

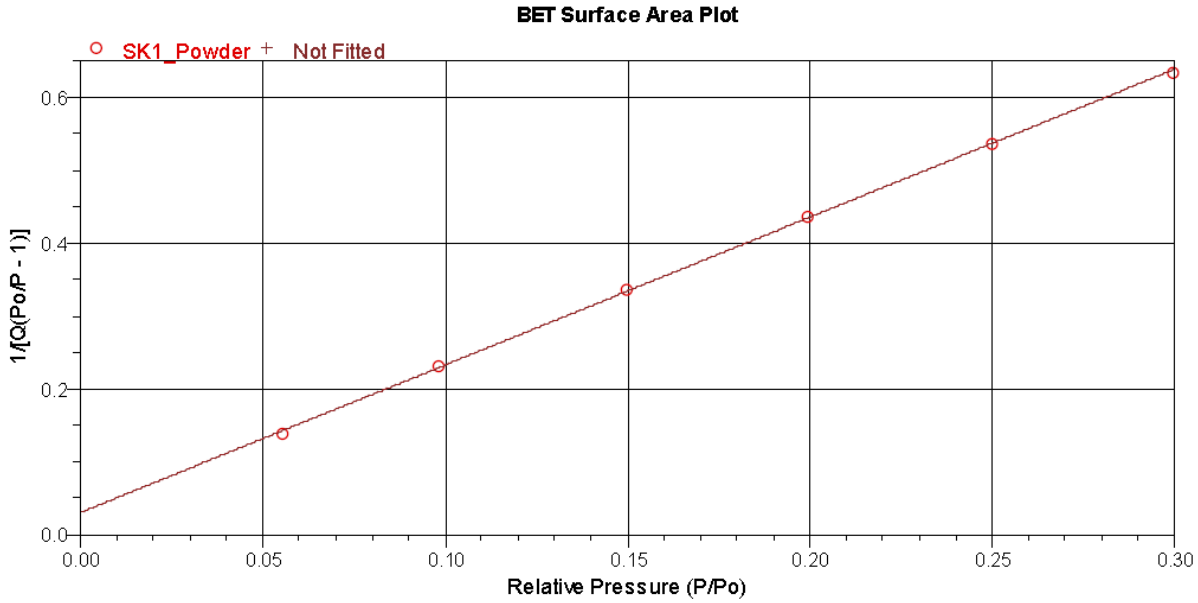
Started: 06.02.2018 16:03:33
Completed: 06.02.2018 17:31:42
Report Time: 06.02.2018 17:33:42
Sample Mass: 2,0891 g
Cold Free Space: 25,9811 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,0730 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.1185 ± 0.0161 m²/g
Slope: 2.023823 ± 0.015287 g/cm³ STP
Y-Intercept: 0.030744 ± 0.002974 g/cm³ STP
C: 66.827629
Qm: 0,4867 cm³/g STP
Correlation Coefficient: 0.9998859
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055566470	0.4222	0.139351
0.098458753	0.4724	0.231181
0.149610234	0.5227	0.336585
0.199528473	0.5705	0.436900
0.249729235	0.6206	0.536364
0.299589537	0.6745	0.634124



Sample: SK2_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\SK2_Powder.SMP

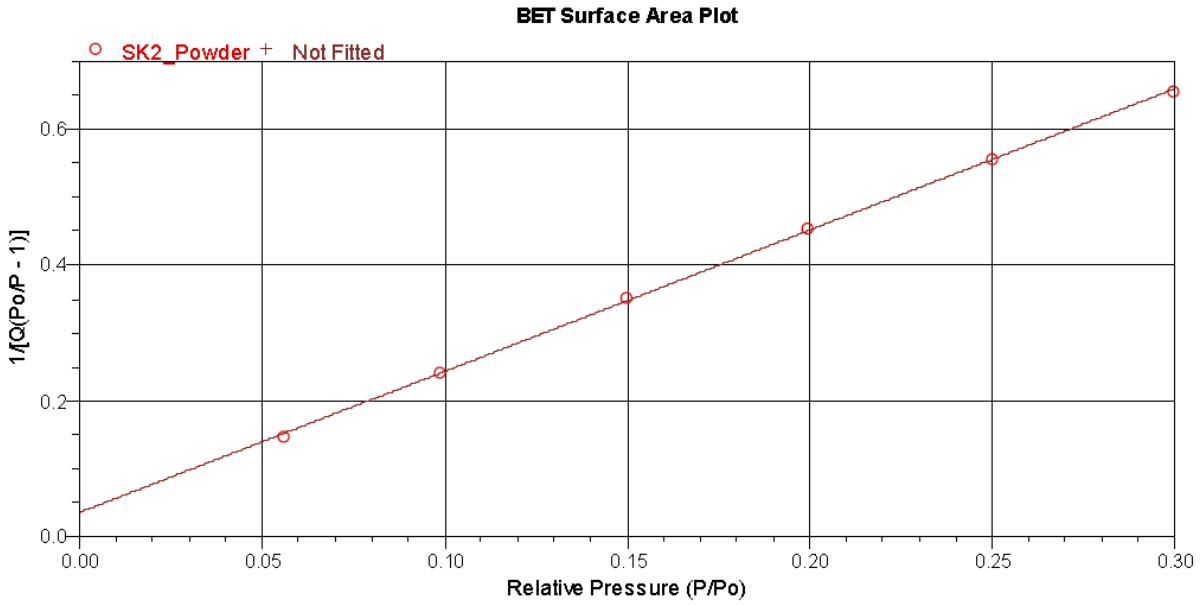
Started: 06.02.2018 16:03:33
Completed: 06.02.2018 17:31:42
Report Time: 06.02.2018 17:33:54
Sample Mass: 2,0670 g
Cold Free Space: 27,2733 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3696 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.0553 ± 0.0192 m²/g
Slope: 2.082736 ± 0.019467 g/cm³ STP
Y-Intercept: 0.034986 ± 0.003787 g/cm³ STP
C: 60.530315
Qm: 0,4722 cm³/g STP
Correlation Coefficient: 0.9998253
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055806119	0.4037	0.146412
0.098482080	0.4525	0.241416
0.149636887	0.5021	0.350491
0.199494631	0.5494	0.453565
0.249688370	0.5991	0.555434
0.299448328	0.6528	0.654797



Sample: SK3_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\SK3_Powder.SMP

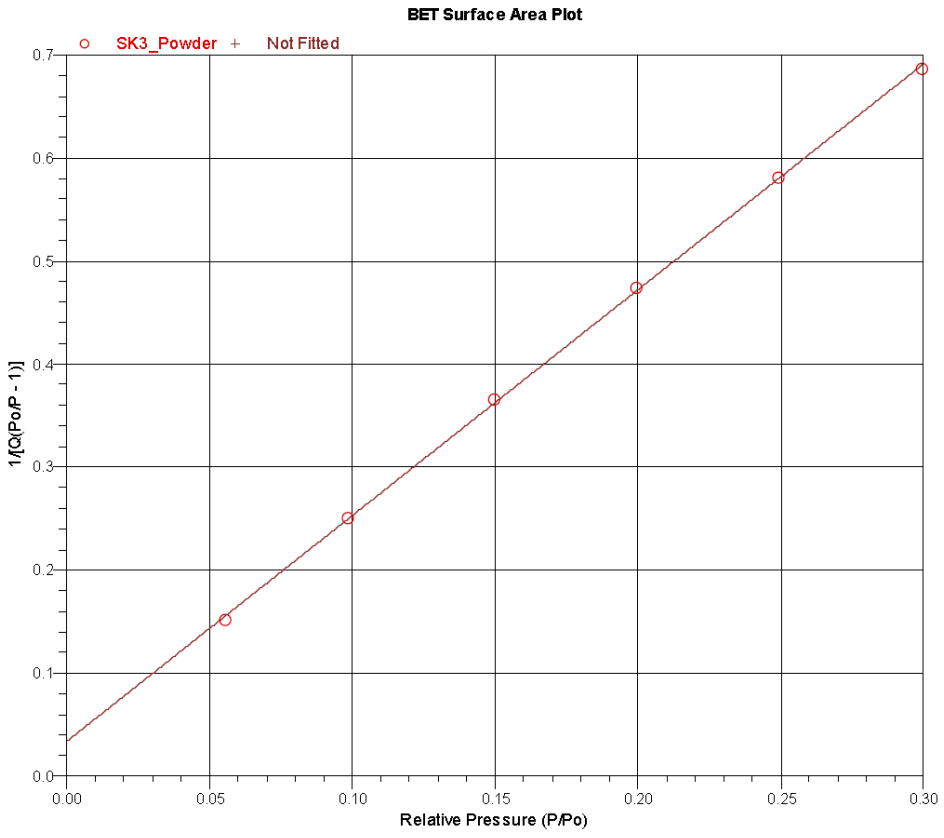
Started: 21.02.2018 14:05:25
Completed: 21.02.2018 15:26:22
Report Time: 21.02.2018 15:26:54
Sample Mass: 2,0745 g
Cold Free Space: 27,0134 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3143 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.9555 ± 0.0162 m²/g
Slope: 2.192289 ± 0.018118 g/cm³ STP
Y-Intercept: 0.033490 ± 0.003525 g/cm³ STP
C: 66.460694
Qm: 0,4493 cm³/g STP
Correlation Coefficient: 0.9998634
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055791120	0.3903	0.151383
0.098580142	0.4362	0.250741
0.149609541	0.4820	0.364998
0.199604250	0.5260	0.474112
0.249509106	0.5724	0.580841
0.299610160	0.6229	0.686698



Sample: SK4_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\SK4_Powder.SMP

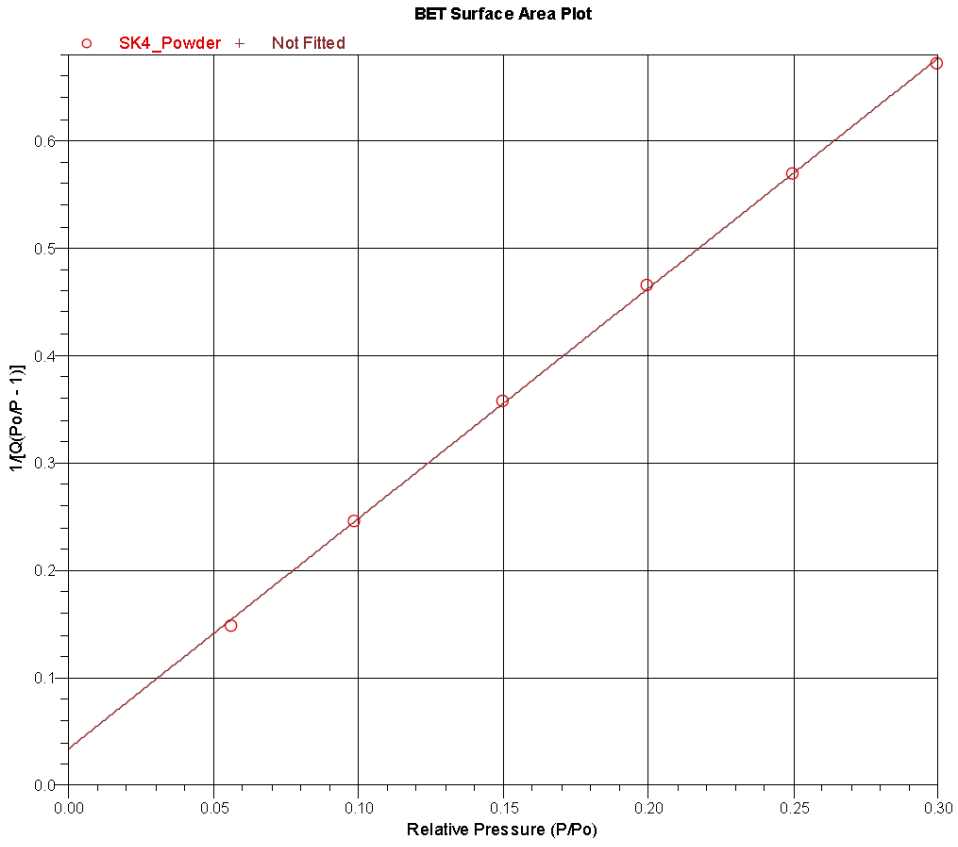
Started: 21.02.2018 14:05:25
Completed: 21.02.2018 15:26:22
Report Time: 21.02.2018 15:27:10
Sample Mass: 2,0480 g
Cold Free Space: 26,7155 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,1983 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.9993 ± 0.0180 m²/g
Slope: 2.143225 ± 0.019247 g/cm³ STP
Y-Intercept: 0.033807 ± 0.003745 g/cm³ STP
C: 64.395441
Qm: 0,4593 cm³/g STP
Correlation Coefficient: 0.9998387
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055914491	0.3975	0.148987
0.098600707	0.4442	0.246274
0.149638120	0.4912	0.358230
0.199635323	0.5364	0.464976
0.249588826	0.5845	0.569087
0.299591395	0.6365	0.672038



Sample: SK5_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\SK5_Powder.SMP

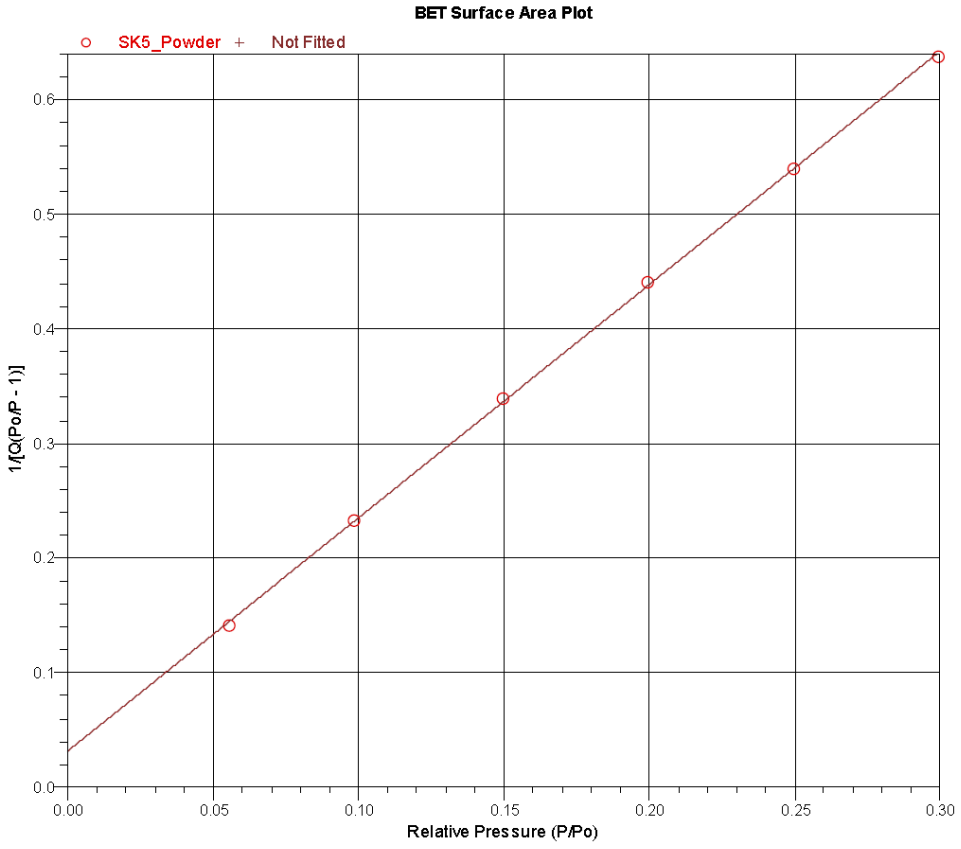
Started: 21.02.2018 14:05:25
Completed: 21.02.2018 15:26:23
Report Time: 21.02.2018 15:27:24
Sample Mass: 2,0398 g
Cold Free Space: 27,1628 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3247 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.1053 ± 0.0181 m²/g
Slope: 2.036004 ± 0.017443 g/cm³ STP
Y-Intercept: 0.031397 ± 0.003393 g/cm³ STP
C: 65.846843
Qm: 0,4837 cm³/g STP
Correlation Coefficient: 0.9998532
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055729417	0.4198	0.140583
0.098549849	0.4688	0.233188
0.149577574	0.5184	0.339303
0.199608806	0.5658	0.440804
0.249541684	0.6162	0.539641
0.299599286	0.6705	0.637975



C. BET Report for Flooded Chalk

Liège

Sample: L1-1(F)_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\F...\L1-1(F)_Powder.SMP

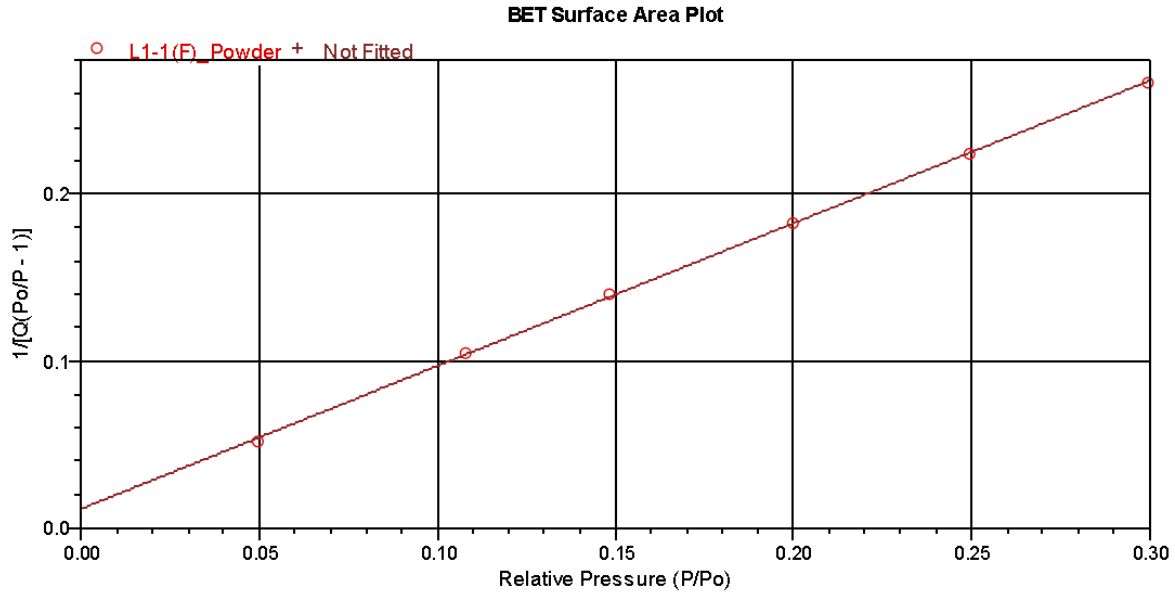
Started: 07.06.2018 14:55:34
Completed: 07.06.2018 16:21:22
Report Time: 07.06.2018 16:21:55
Sample Mass: 1,9112 g
Cold Free Space: 27,0290 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3788 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 5.0301 ± 0.0392 m²/g
Slope: 0.853631 ± 0.006615 g/cm³ STP
Y-Intercept: 0.011679 ± 0.001289 g/cm³ STP
C: 74.089717
Qm: 1,1557 cm³/g STP
Correlation Coefficient: 0.9998799
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.049468912	0.9982	0.052139
0.107861068	1.1551	0.104670
0.148352774	1.2480	0.139582
0.199623000	1.3636	0.182906
0.249491153	1.4807	0.224514
0.299546432	1.6060	0.266285



Sample: L1-7(F)_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\F...\L1-7(F)_Powder.SMP

Started: 07.06.2018 13:08:42
Completed: 07.06.2018 14:29:30
Report Time: 07.06.2018 14:52:24
Sample Mass: 1,6289 g
Cold Free Space: 27,8802 cm³
Low Pressure Dose: None
Automatic Degas: No

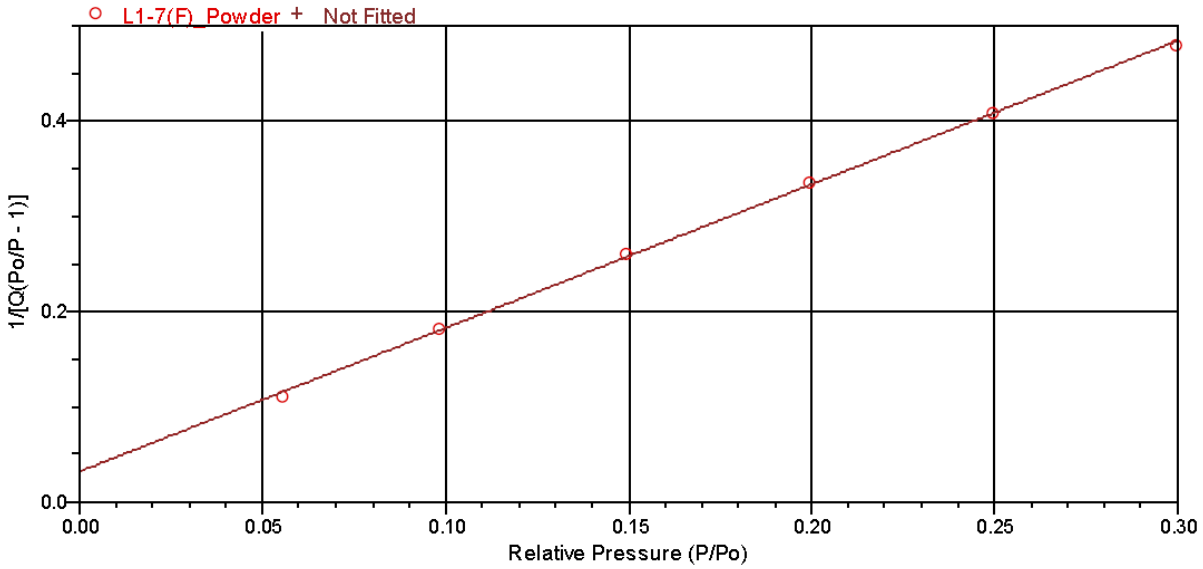
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,5296 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.8264 ± 0.0384 m²/g
Slope: 1.508227 ± 0.020539 g/cm³ STP
Y-Intercept: 0.031740 ± 0.003993 g/cm³ STP
C: 48.517479
Qm: 0,6494 cm³/g STP
Correlation Coefficient: 0.9996293
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055637080	0.5328	0.110566
0.098389117	0.6010	0.181573
0.149447442	0.6729	0.261134
0.199505147	0.7417	0.336017
0.249444190	0.8141	0.408255
0.299424568	0.8917	0.479323

BET Surface Area Plot



Kansas

Sample: KA8-3(F)_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\...\KA8-3(F)_Powder.SMP

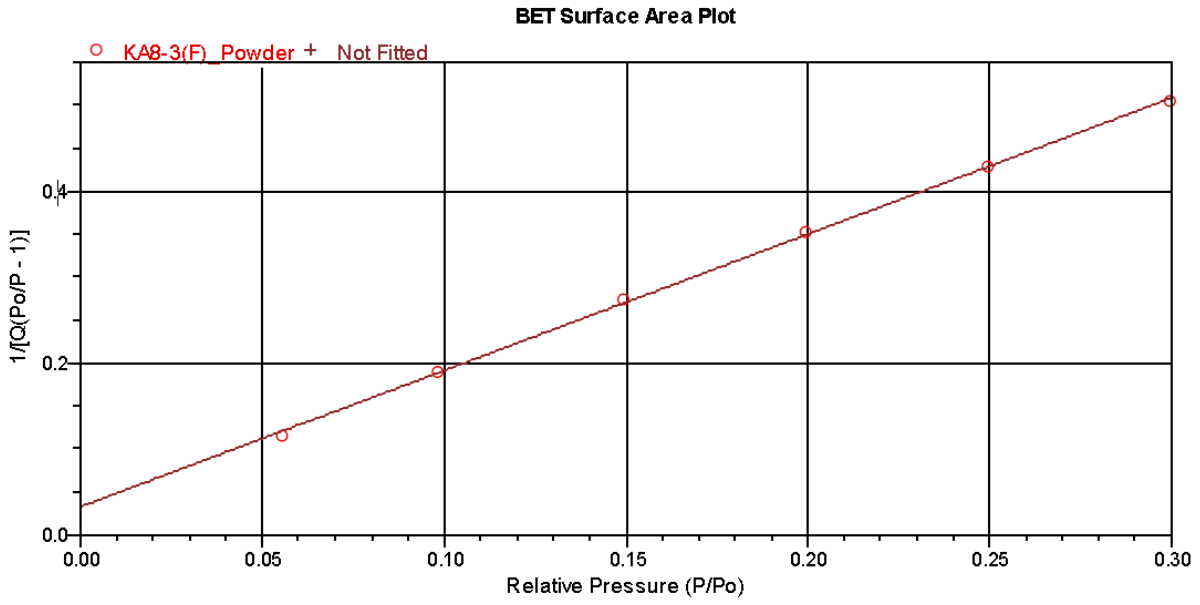
Started: 07.06.2018 14:55:34
Completed: 07.06.2018 16:21:23
Report Time: 07.06.2018 16:21:35
Sample Mass: 1,8180 g
Cold Free Space: 28,1034 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,6899 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.6893 ± 0.0319 m²/g
Slope: 1.585883 ± 0.018832 g/cm³ STP
Y-Intercept: 0.032618 ± 0.003660 g/cm³ STP
C: 49.620460
Qm: 0,6179 cm³/g STP
Correlation Coefficient: 0.9997181
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055479261	0.5067	0.115923
0.098141169	0.5741	0.189565
0.149469995	0.6427	0.273439
0.199439262	0.7080	0.351893
0.249457182	0.7757	0.428484
0.299372734	0.8482	0.503735



Sample: KA8-7(F)_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\...\KA8-7(F)_Powder.SMP

Started: 07.06.2018 14:55:34
Completed: 07.06.2018 16:21:23
Report Time: 07.06.2018 16:21:46
Sample Mass: 1,3850 g
Cold Free Space: 26,8481 cm³
Low Pressure Dose: None
Automatic Degas: No

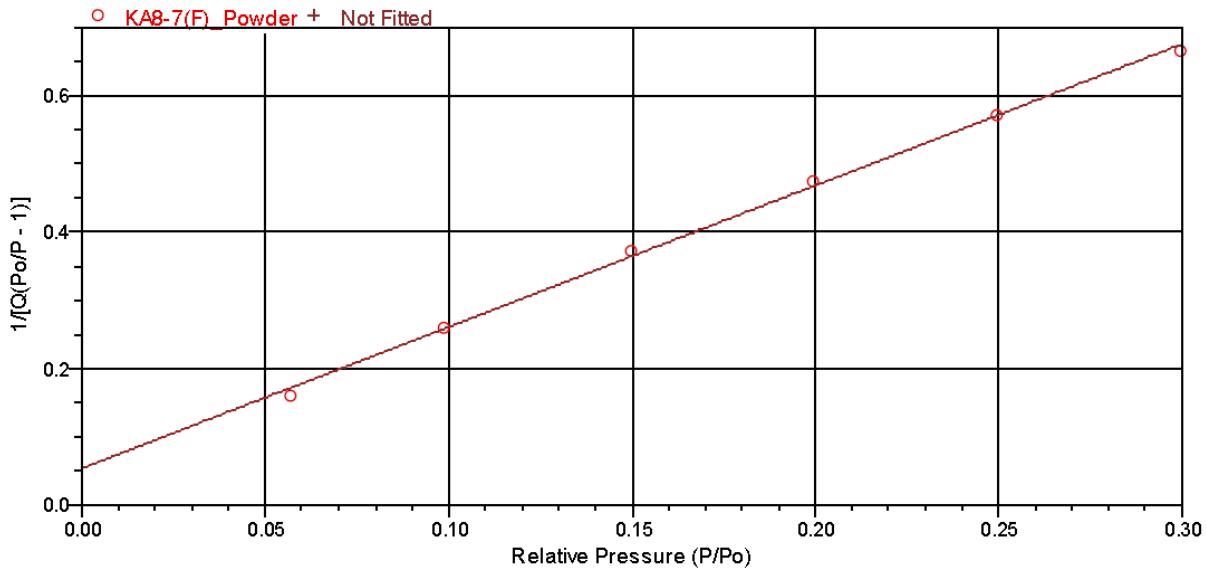
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3328 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.0445 ± 0.0410 m²/g
Slope: 2.075625 ± 0.041948 g/cm³ STP
Y-Intercept: 0.053288 ± 0.008160 g/cm³ STP
C: 39.950830
Qm: 0,4697 cm³/g STP
Correlation Coefficient: 0.9991841
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.056674092	0.3730	0.161057
0.098935872	0.4213	0.260640
0.149578151	0.4731	0.371770
0.199556843	0.5250	0.474909
0.249434799	0.5809	0.572084
0.299416220	0.6416	0.666141

BET Surface Area Plot



D. BET Report for Other Chalk Samples

Mattinata Formation

Sample: MATK52_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\It...\MATK52_Pellet.SMP

Started: 05.06.2018 13:54:38
Completed: 05.06.2018 15:16:56
Report Time: 05.06.2018 15:17:39
Sample Mass: 3,9370 g
Cold Free Space: 24,7183 cm³
Low Pressure Dose: None
Automatic Degas: No

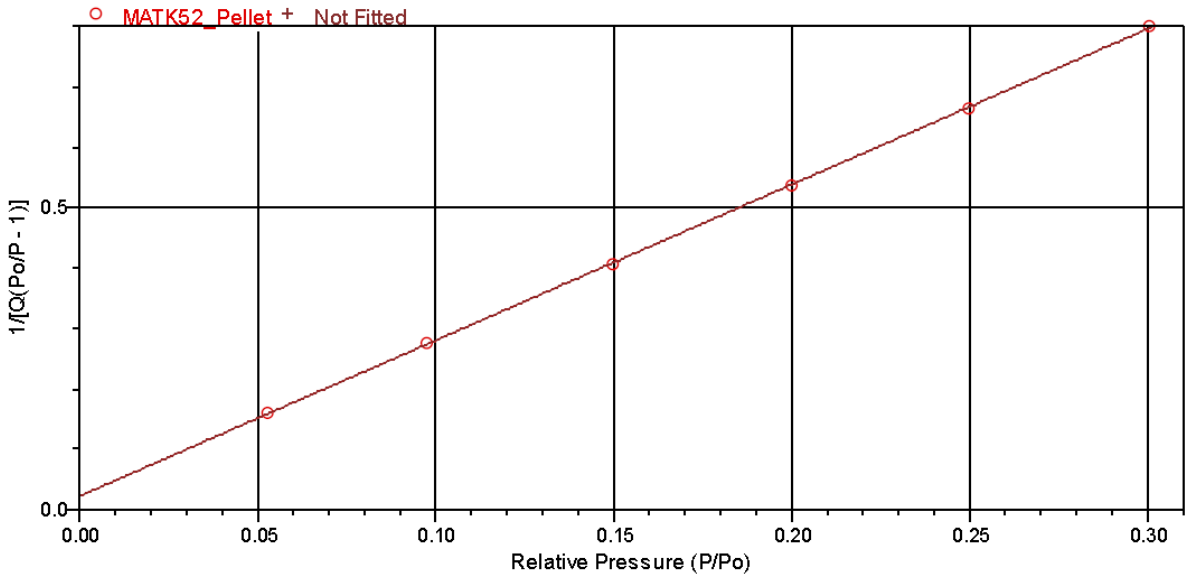
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,6421 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.6743 ± 0.0062 m²/g
Slope: 2.577428 ± 0.009473 g/cm³ STP
Y-Intercept: 0.022244 ± 0.001843 g/cm³ STP
C: 116.869749
Qm: 0,3847 cm³/g STP
Correlation Coefficient: 0.9999730
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.052827336	0.3514	0.158739
0.097623904	0.3931	0.275217
0.149577050	0.4318	0.407342
0.199797030	0.4666	0.535142
0.249939631	0.5013	0.664737
0.300234737	0.5373	0.798587

BET Surface Area Plot



Sample: MATK9_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Italy\MATK9_Pellet.SMP

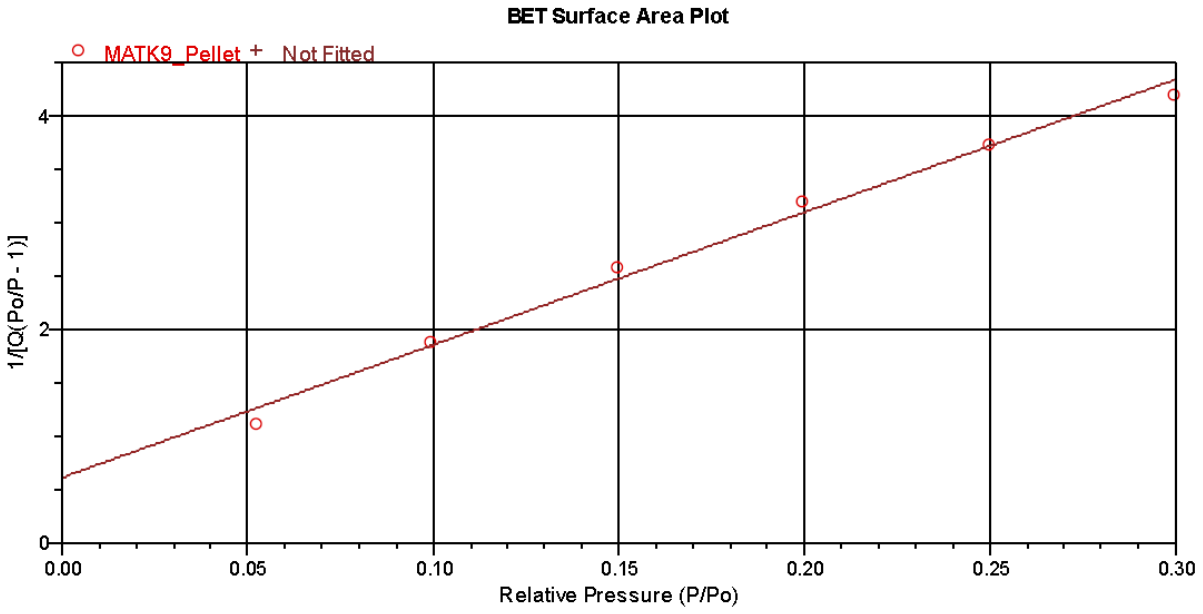
Started: 05.06.2018 13:54:38
Completed: 05.06.2018 15:16:56
Report Time: 05.06.2018 15:17:26
Sample Mass: 3,7997 g
Cold Free Space: 24,4561 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,5981 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.3337 ± 0.0159 m²/g
Slope: 12.429870 ± 0.610055 g/cm³ STP
Y-Intercept: 0.613079 ± 0.118569 g/cm³ STP
C: 21.274503
Qm: 0,0767 cm³/g STP
Correlation Coefficient: 0.9952169
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.052147562	0.0493	1.115347
0.099237700	0.0585	1.882704
0.149623475	0.0679	2.590577
0.199546788	0.0780	3.197004
0.249482571	0.0891	3.731751
0.299387570	0.1016	4.205315



Sample: MATK6_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Italy\MATK6_Powder.SMP

Started: 05.06.2018 15:28:47
Completed: 05.06.2018 16:50:33
Report Time: 05.06.2018 16:51:06
Sample Mass: 1,7623 g
Cold Free Space: 27,3734 cm³
Low Pressure Dose: None
Automatic Degas: No

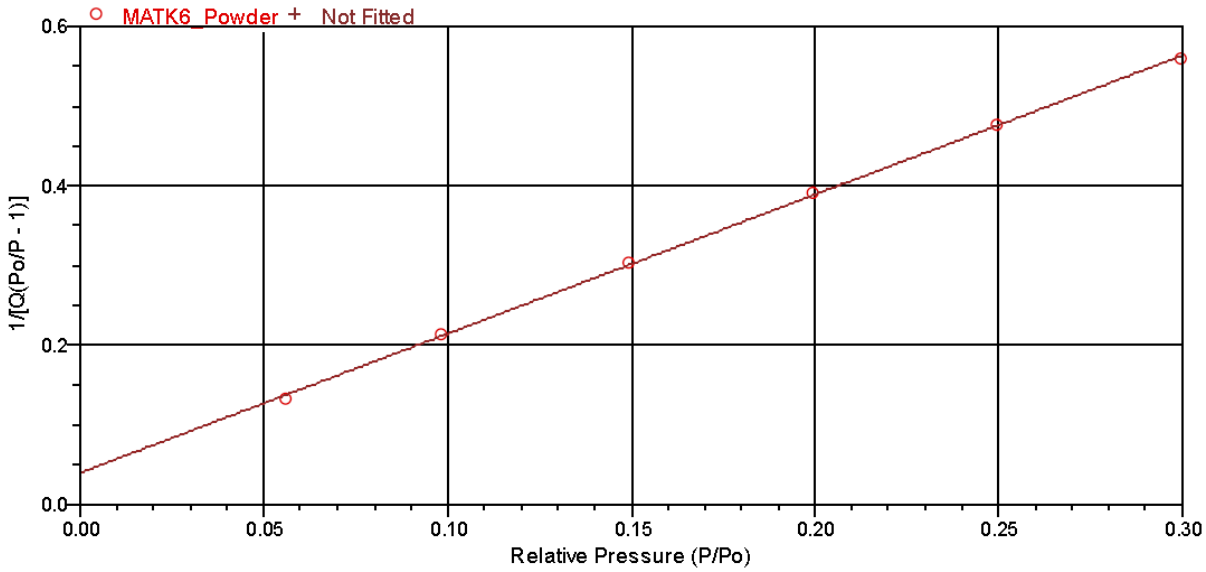
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,4215 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.4371 ± 0.0270 m²/g
Slope: 1.746493 ± 0.019425 g/cm³ STP
Y-Intercept: 0.039499 ± 0.003776 g/cm³ STP
C: 45.215771
Qm: 0,5599 cm³/g STP
Correlation Coefficient: 0.9997527
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055735828	0.4474	0.131931
0.098126523	0.5123	0.212384
0.149463479	0.5772	0.304464
0.199446391	0.6376	0.390744
0.249486580	0.6991	0.475486
0.299472446	0.7650	0.558829

BET Surface Area Plot



Sample: MATK2_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Italy\MATK2_Pellet.SMP

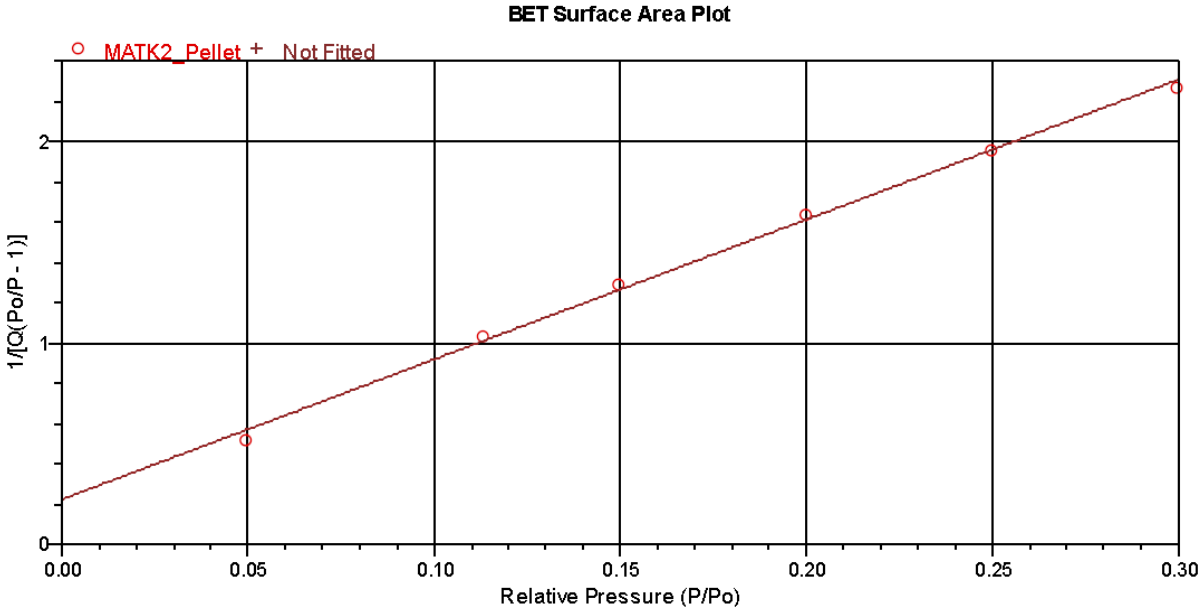
Started: 05.06.2018 13:54:38
Completed: 05.06.2018 15:16:55
Report Time: 05.06.2018 15:17:16
Sample Mass: 3,2161 g
Cold Free Space: 24,6724 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,6041 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.6070 ± 0.0150 m²/g
Slope: 6.949230 ± 0.174360 g/cm³ STP
Y-Intercept: 0.221972 ± 0.034099 g/cm³ STP
C: 32.306830
Qm: 0,1394 cm³/g STP
Correlation Coefficient: 0.9987433
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.049171024	0.0996	0.519394
0.112930961	0.1238	1.027976
0.149351654	0.1361	1.289907
0.199733208	0.1526	1.635267
0.249663690	0.1699	1.958624
0.299614554	0.1884	2.270078



Sample: MATK35_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\It...\MATK35_Powder.SMP

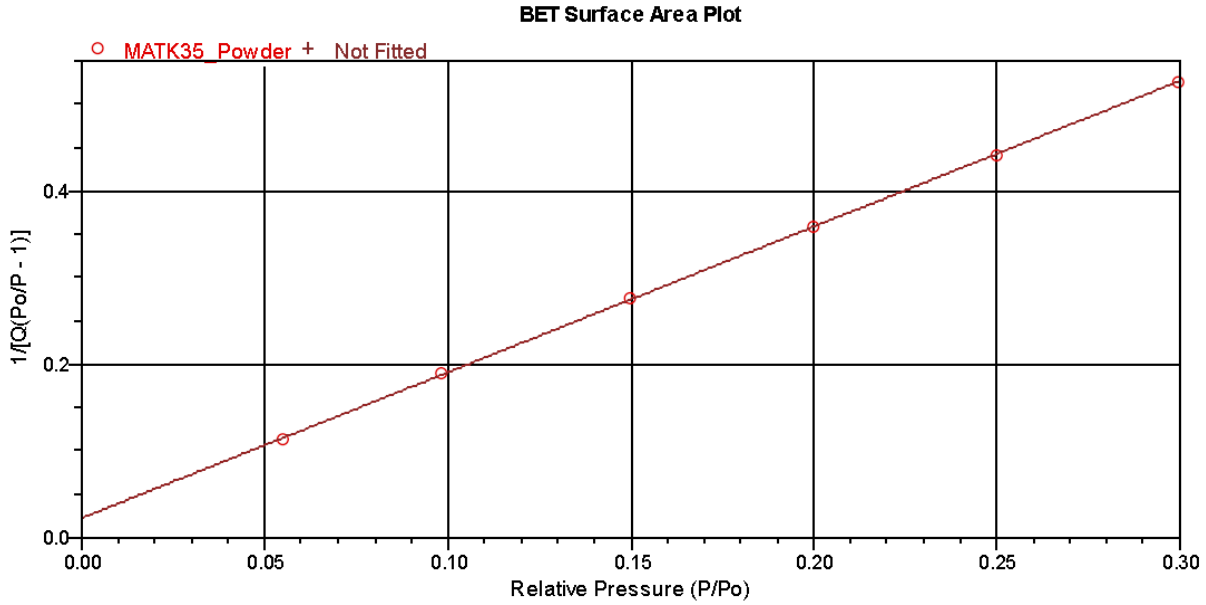
Started: 05.06.2018 15:28:47
Completed: 05.06.2018 16:50:34
Report Time: 05.06.2018 16:51:18
Sample Mass: 2,0162 g
Cold Free Space: 27,5692 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3989 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.5548 ± 0.0113 m²/g
Slope: 1.681273 ± 0.007422 g/cm³ STP
Y-Intercept: 0.022408 ± 0.001444 g/cm³ STP
C: 76.028984
Qm: 0,5870 cm³/g STP
Correlation Coefficient: 0.9999610
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054961915	0.5158	0.112757
0.098227887	0.5775	0.188632
0.149583132	0.6384	0.275507
0.199614066	0.6952	0.358716
0.249711550	0.7534	0.441739
0.299717686	0.8145	0.525488



Sample: MATK1_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Italy\MATK1_Pellet.SMP

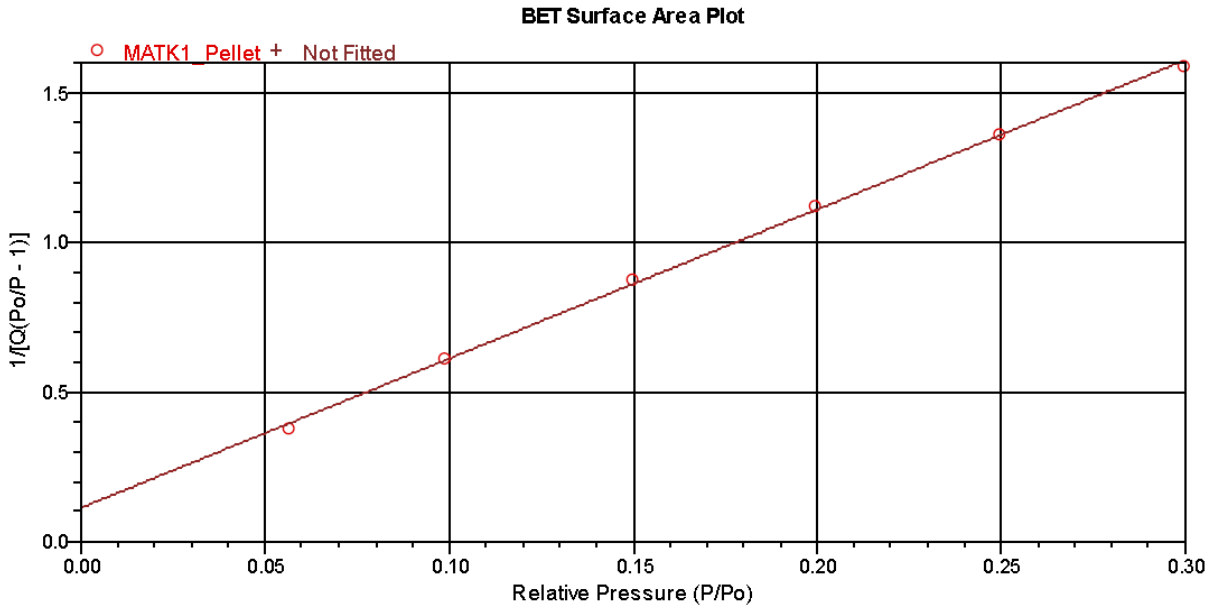
Started: 05.06.2018 15:28:47
Completed: 05.06.2018 16:50:34
Report Time: 05.06.2018 16:50:51
Sample Mass: 3,2605 g
Cold Free Space: 24,5189 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,6255 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.8537 ± 0.0131 m²/g
Slope: 4.986336 ± 0.076620 g/cm³ STP
Y-Intercept: 0.112308 ± 0.014909 g/cm³ STP
C: 45.398808
Qm: 0,1961 cm³/g STP
Correlation Coefficient: 0.9995281
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.056418050	0.1593	0.375273
0.098847628	0.1800	0.609324
0.149651704	0.2014	0.873616
0.199565289	0.2226	1.120176
0.249630259	0.2448	1.358964
0.299490391	0.2689	1.590116



Hod Formation

Sample: VE13_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Nort...\VE13_Pellet.SMP

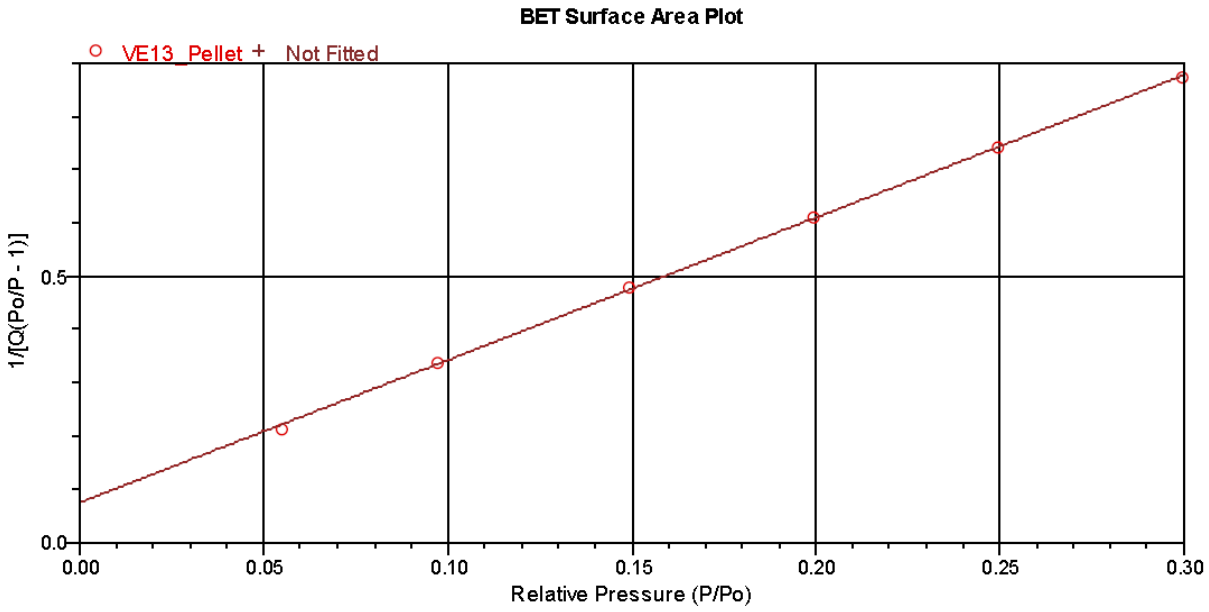
Started: 06.06.2018 13:40:19
Completed: 06.06.2018 15:01:57
Report Time: 06.06.2018 15:04:34
Sample Mass: 3,4470 g
Cold Free Space: 25,5121 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,9035 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.5820 ± 0.0161 m²/g
Slope: 2.676452 ± 0.027469 g/cm³ STP
Y-Intercept: 0.074802 ± 0.005337 g/cm³ STP
C: 36.780334
Qm: 0,3635 cm³/g STP
Correlation Coefficient: 0.9997894
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054810154	0.2711	0.213902
0.097224066	0.3180	0.338698
0.149254691	0.3655	0.480064
0.199411690	0.4073	0.611559
0.249475642	0.4484	0.741313
0.299601506	0.4900	0.872957



Tor Formation

Sample: VE27_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Nort...\VE27_Powder.SMP

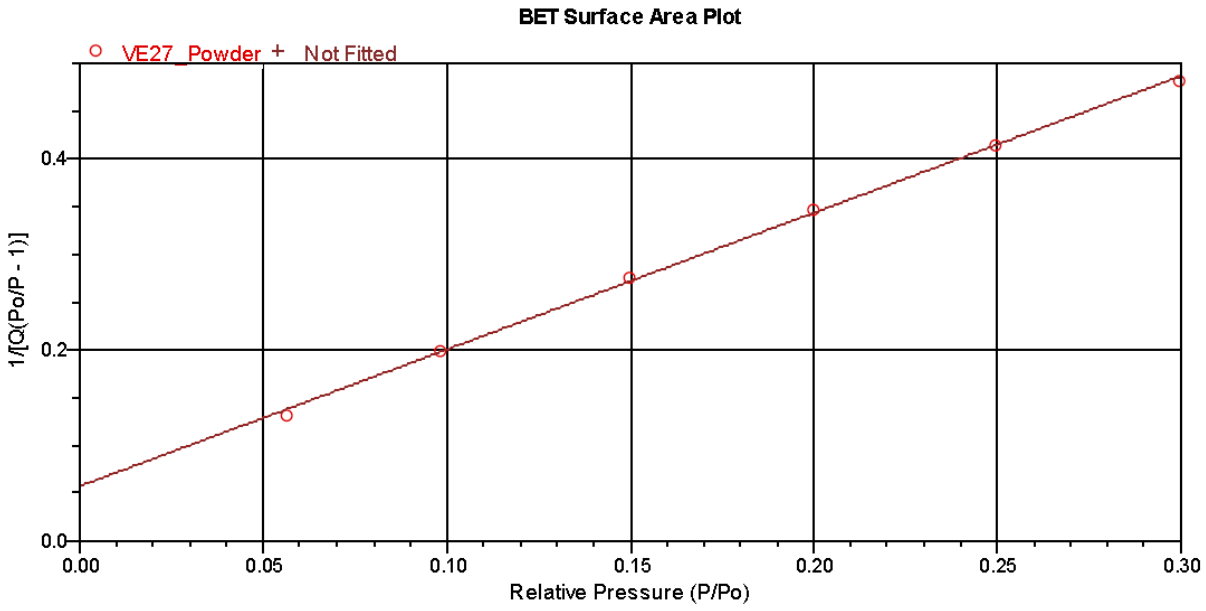
Started: 06.06.2018 15:14:56
Completed: 06.06.2018 16:35:43
Report Time: 06.06.2018 16:39:38
Sample Mass: 1,0540 g
Cold Free Space: 28,7037 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,6977 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.9240 ± 0.0479 m²/g
Slope: 1.431565 ± 0.023942 g/cm³ STP
Y-Intercept: 0.057015 ± 0.004658 g/cm³ STP
C: 26.108619
Qm: 0,6718 cm³/g STP
Correlation Coefficient: 0.9994410
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.056499197	0.4536	0.132024
0.098249122	0.5469	0.199219
0.149569659	0.6378	0.275766
0.199605111	0.7193	0.346724
0.249552513	0.8018	0.414746
0.299555842	0.8889	0.481094



Sample: VE34_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Nort...\VE34_Powder.SMP

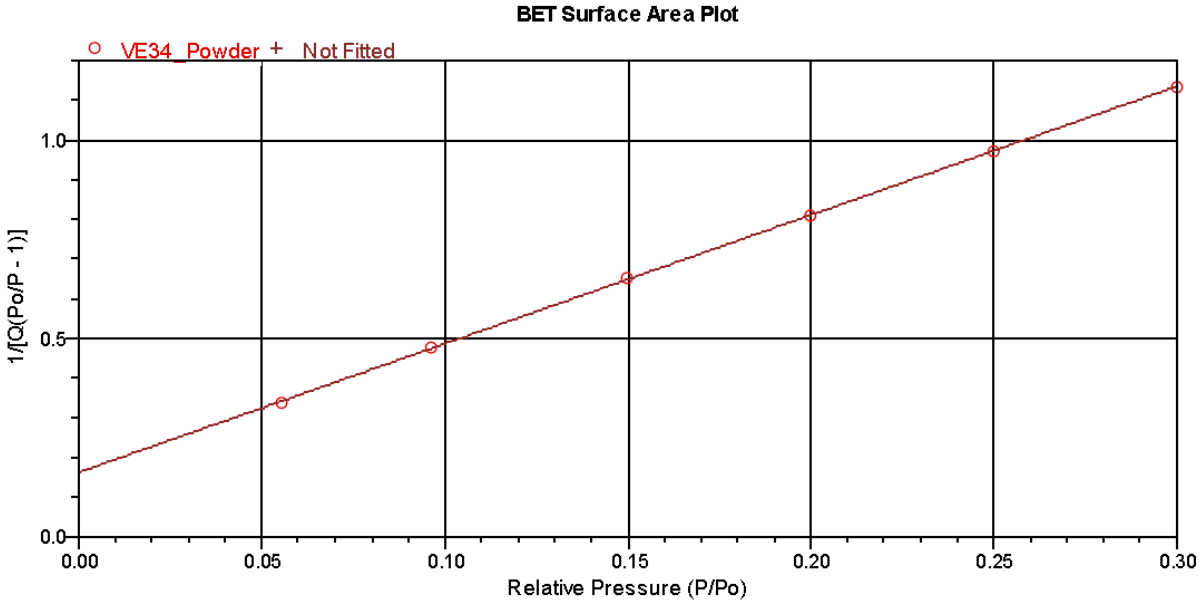
Started: 07.06.2018 13:08:42
Completed: 07.06.2018 14:29:29
Report Time: 07.06.2018 14:52:51
Sample Mass: 3,6246 g
Cold Free Space: 24,8853 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,7074 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.2781 ± 0.0053 m²/g
Slope: 3.243685 ± 0.013807 g/cm³ STP
Y-Intercept: 0.161732 ± 0.002685 g/cm³ STP
C: 21.055959
Qm: 0,2936 cm³/g STP
Correlation Coefficient: 0.9999638
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055392626	0.1737	0.337502
0.096256382	0.2235	0.476508
0.149574452	0.2707	0.649742
0.199650837	0.3080	0.810041
0.249767200	0.3430	0.970668
0.299847190	0.3779	1.133384



Sample: VE37_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Nort...\VE37_Powder.SMP

Started: 06.06.2018 15:14:56
Completed: 06.06.2018 16:35:42
Report Time: 06.06.2018 16:39:58
Sample Mass: 1,1590 g
Cold Free Space: 28,0125 cm³
Low Pressure Dose: None
Automatic Degas: No

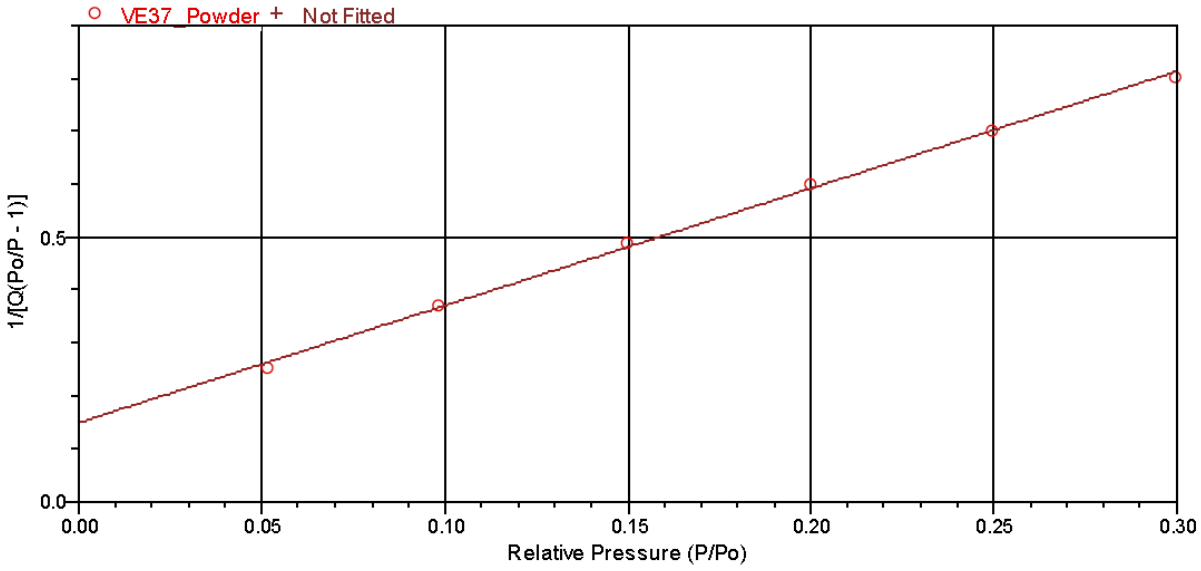
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,5686 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.8419 ± 0.0392 m²/g
Slope: 2.214039 ± 0.049361 g/cm³ STP
Y-Intercept: 0.149020 ± 0.009592 g/cm³ STP
C: 15.857318
Qm: 0,4232 cm³/g STP
Correlation Coefficient: 0.9990074
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.051626178	0.2167	0.251163
0.098129302	0.2943	0.369755
0.149645652	0.3591	0.490087
0.199663710	0.4164	0.599080
0.249569030	0.4733	0.702686
0.299527379	0.5332	0.802018

BET Surface Area Plot



Sample: VE50_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Nort...\VE50_Pellet.SMP

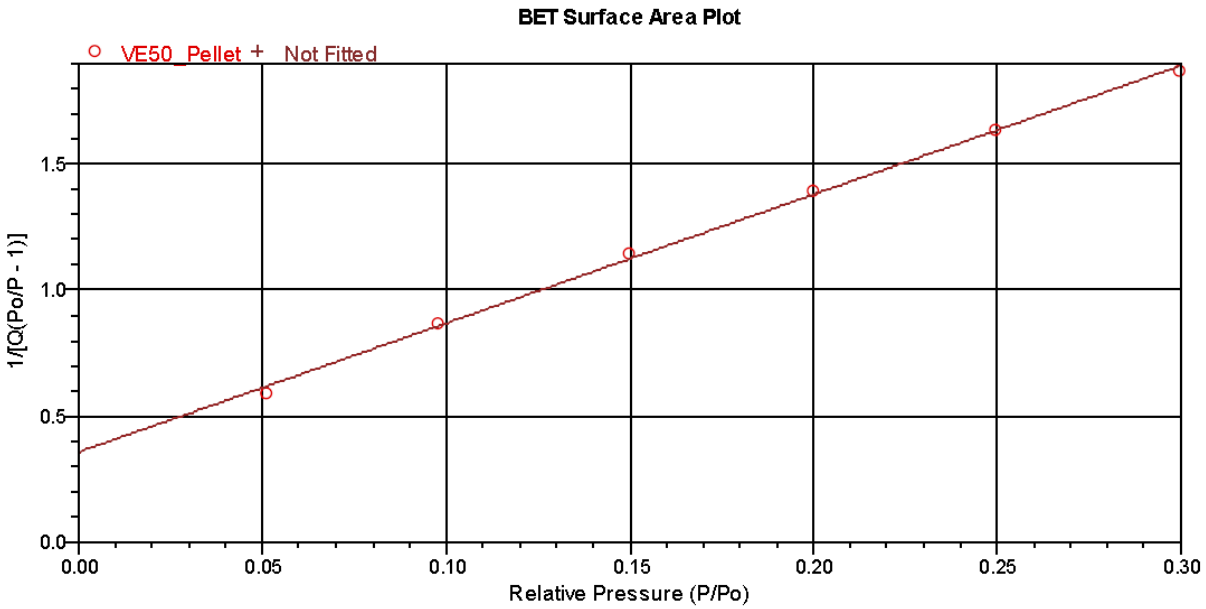
Started: 06.06.2018 13:40:19
Completed: 06.06.2018 15:01:57
Report Time: 06.06.2018 15:04:58
Sample Mass: 2,8189 g
Cold Free Space: 25,1803 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,7643 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.7951 ± 0.0159 m²/g
Slope: 5.117367 ± 0.107448 g/cm³ STP
Y-Intercept: 0.356653 ± 0.020880 g/cm³ STP
C: 15.348287
Qm: 0,1827 cm³/g STP
Correlation Coefficient: 0.9991194
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.051086127	0.0911	0.590766
0.097954523	0.1252	0.867231
0.149669435	0.1539	1.143524
0.199668198	0.1788	1.395562
0.249631947	0.2034	1.635219
0.299662122	0.2289	1.868942



Sample: VE30_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Nort...\VE30_Pellet.SMP

Started: 06.06.2018 13:40:19
Completed: 06.06.2018 15:01:56
Report Time: 06.06.2018 15:04:46
Sample Mass: 3,6430 g
Cold Free Space: 24,9215 cm³
Low Pressure Dose: None
Automatic Degas: No

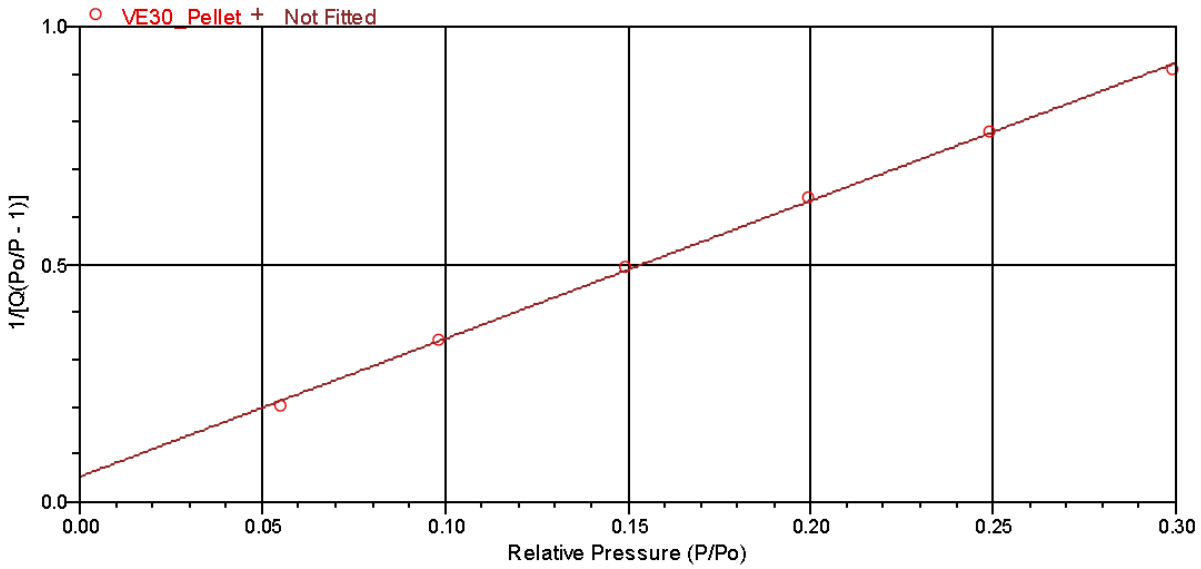
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,7277 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.4728 ± 0.0248 m²/g
Slope: 2.902572 ± 0.048870 g/cm³ STP
Y-Intercept: 0.052676 ± 0.009489 g/cm³ STP
C: 56.102686
Qm: 0,3384 cm³/g STP
Correlation Coefficient: 0.9994335
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055038520	0.2890	0.201547
0.098343907	0.3210	0.339759
0.149418068	0.3548	0.495111
0.199370483	0.3888	0.640412
0.249169254	0.4264	0.778307
0.298894965	0.4688	0.909302

BET Surface Area Plot



Sample: VE29_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Nort...\VE29_Pellet.SMP

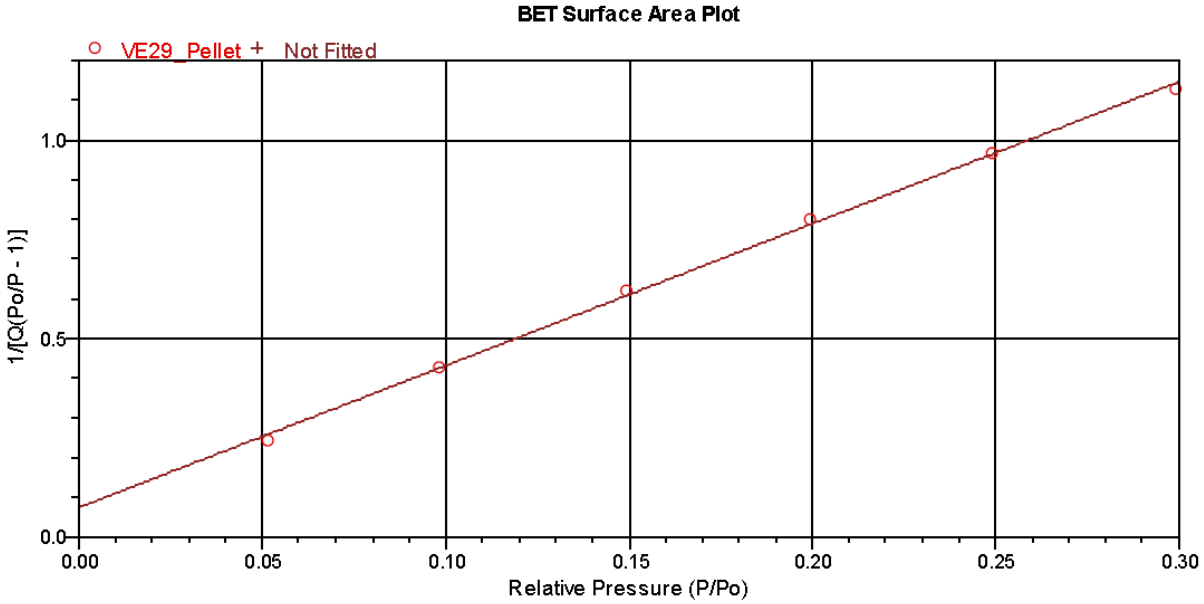
Started: 06.06.2018 15:14:56
Completed: 06.06.2018 16:35:43
Report Time: 06.06.2018 16:39:48
Sample Mass: 3,7158 g
Cold Free Space: 23,8495 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,4333 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.1930 ± 0.0235 m²/g
Slope: 3.574762 ± 0.070580 g/cm³ STP
Y-Intercept: 0.073684 ± 0.013686 g/cm³ STP
C: 49.514812
Qm: 0,2741 cm³/g STP
Correlation Coefficient: 0.9992213
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.051734780	0.2253	0.242147
0.098177614	0.2542	0.428233
0.149286718	0.2828	0.620581
0.199154477	0.3116	0.798076
0.249081873	0.3431	0.966722
0.298801753	0.3783	1.126394



Ulster White Limestone Formation

Sample: W3_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Northe...\W3_Pellet.SMP

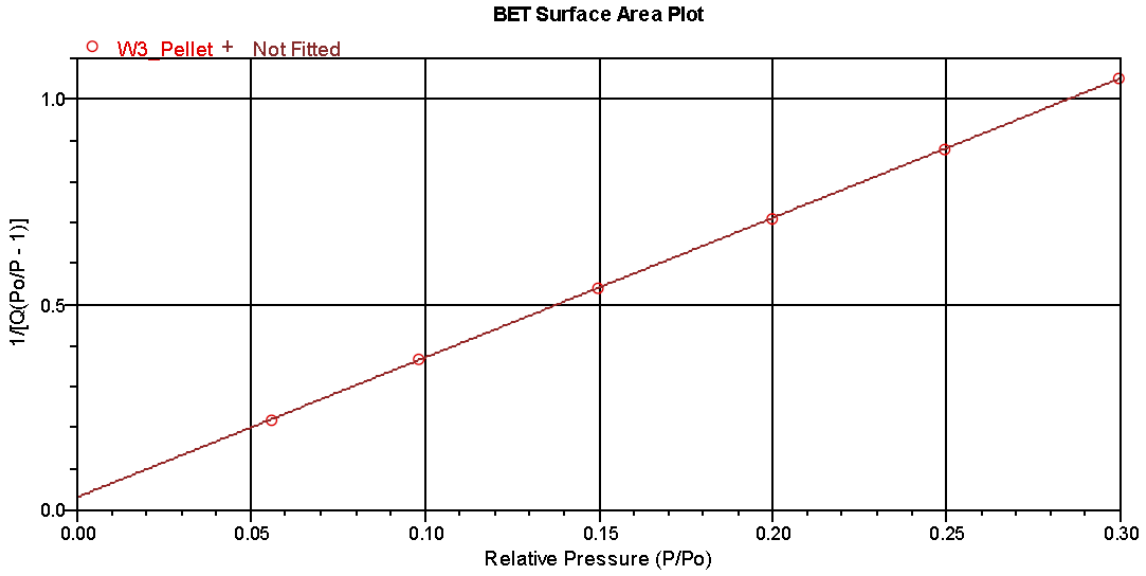
Started: 04.06.2018 15:26:26
Completed: 04.06.2018 16:50:21
Report Time: 04.06.2018 16:50:33
Sample Mass: 3,9779 g
Cold Free Space: 24,2496 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,5236 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.2683 ± 0.0030 m²/g
Slope: 3.400924 ± 0.007866 g/cm³ STP
Y-Intercept: 0.030961 ± 0.001530 g/cm³ STP
C: 110.845510
Qm: 0,2914 cm³/g STP
Correlation Coefficient: 0.9999893
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055957249	0.2706	0.219082
0.098292137	0.2973	0.366626
0.149557395	0.3249	0.541252
0.199688448	0.3512	0.710531
0.249593185	0.3784	0.879038
0.299658824	0.4077	1.049551



Sample: W13_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\North...\W13_Pellet.SMP

Started: 04.06.2018 13:26:43
Completed: 04.06.2018 14:51:32
Report Time: 04.06.2018 15:11:57
Sample Mass: 3,2862 g
Cold Free Space: 24,6287 cm³
Low Pressure Dose: None
Automatic Degas: No

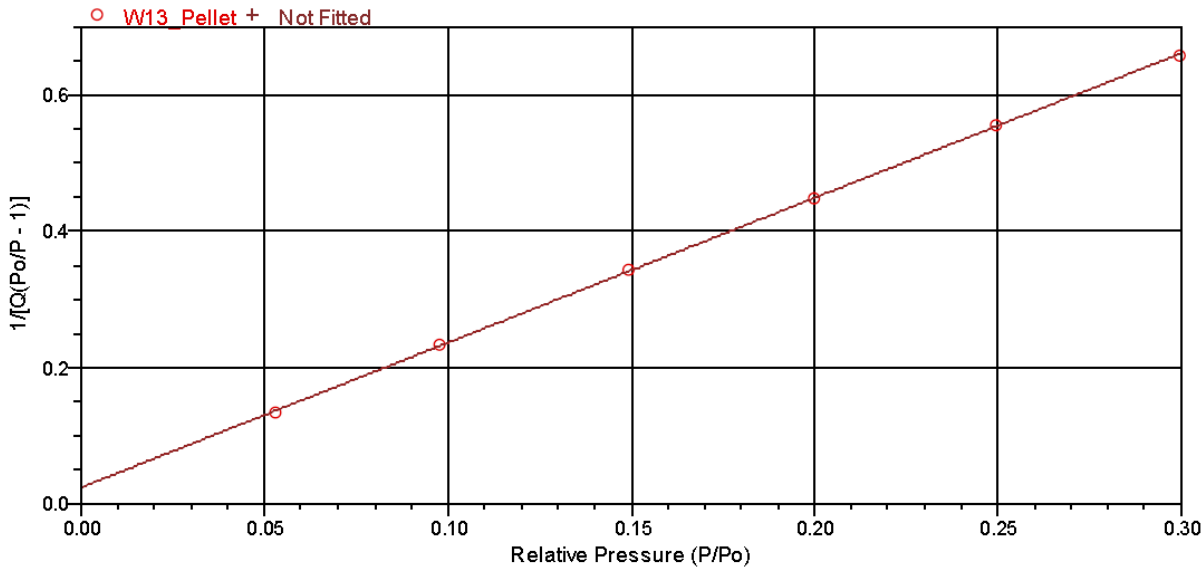
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,6122 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.0238 ± 0.0098 m²/g
Slope: 2.127150 ± 0.010238 g/cm³ STP
Y-Intercept: 0.023590 ± 0.001990 g/cm³ STP
C: 91.171656
Qm: 0,4650 cm³/g STP
Correlation Coefficient: 0.9999537
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.053216927	0.4192	0.134078
0.097876826	0.4659	0.232870
0.149509557	0.5115	0.343701
0.199607992	0.5547	0.449566
0.249603111	0.5998	0.554523
0.299625496	0.6491	0.659117

BET Surface Area Plot



Sample: W23_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\North...\W23_Pellet.SMP

Started: 01.06.2018 15:13:14
Completed: 01.06.2018 16:35:00
Report Time: 01.06.2018 16:37:09
Sample Mass: 3,4539 g
Cold Free Space: 25,6600 cm³
Low Pressure Dose: None
Automatic Degas: No

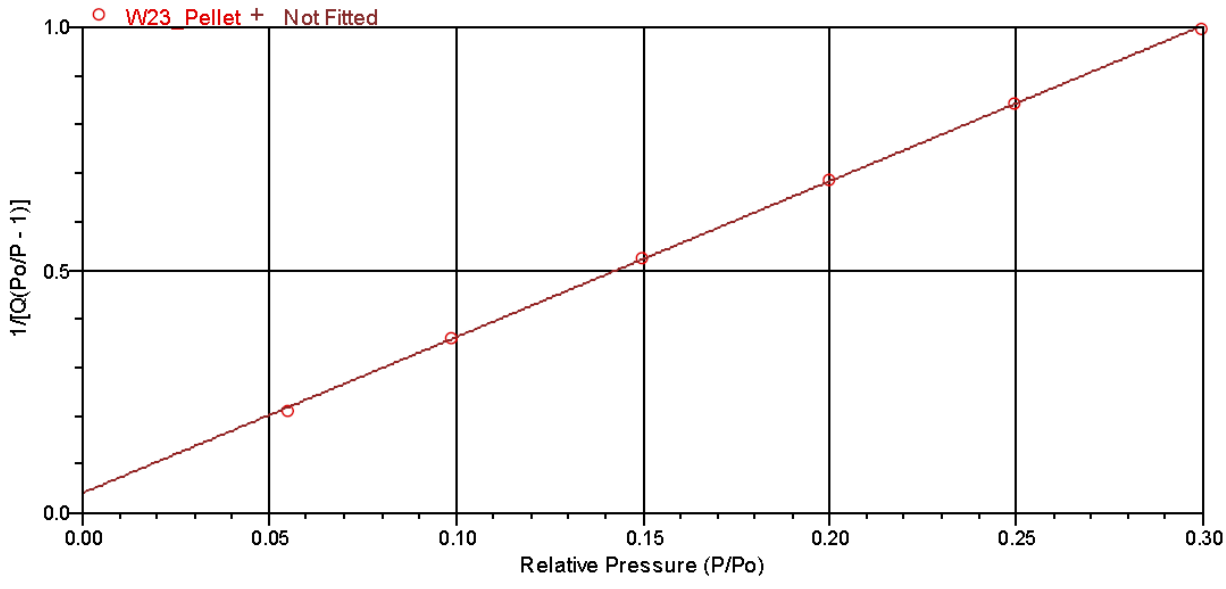
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,8813 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.3394 ± 0.0098 m²/g
Slope: 3.209000 ± 0.023403 g/cm³ STP
Y-Intercept: 0.040757 ± 0.004552 g/cm³ STP
C: 79.735148
Qm: 0,3077 cm³/g STP
Correlation Coefficient: 0.9998936
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054760282	0.2749	0.210744
0.098526883	0.3049	0.358485
0.149588354	0.3348	0.525334
0.199652080	0.3640	0.685294
0.249613919	0.3949	0.842269
0.299561701	0.4288	0.997331

BET Surface Area Plot



Sample: W24_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\North...\W24_Pellet.SMP

Started: 01.06.2018 15:13:14
Completed: 01.06.2018 16:35:00
Report Time: 01.06.2018 16:37:24
Sample Mass: 3,7017 g
Cold Free Space: 23,6163 cm³
Low Pressure Dose: None
Automatic Degas: No

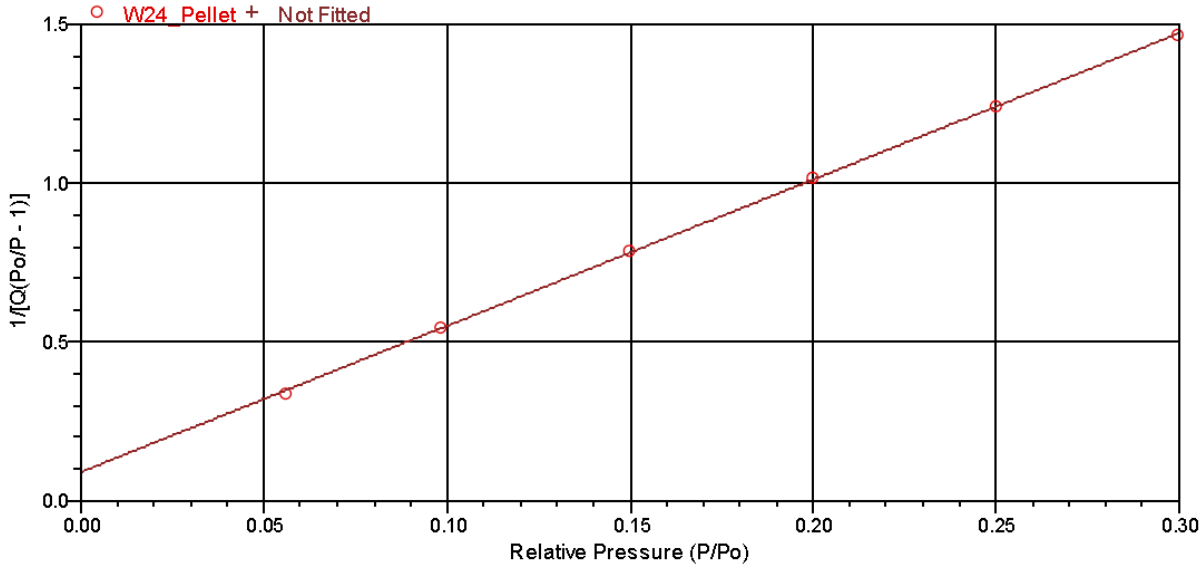
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,3315 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.9269 ± 0.0079 m²/g
Slope: 4.605850 ± 0.039167 g/cm³ STP
Y-Intercept: 0.089794 ± 0.007622 g/cm³ STP
C: 52.293585
Qm: 0,2130 cm³/g STP
Correlation Coefficient: 0.9998554
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055892759	0.1756	0.337054
0.098456272	0.1997	0.546778
0.149574755	0.2235	0.786941
0.199663480	0.2458	1.015019
0.249690569	0.2685	1.239391
0.299727921	0.2924	1.463567

BET Surface Area Plot



Sample: W19_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\North...\W19_Pellet.SMP

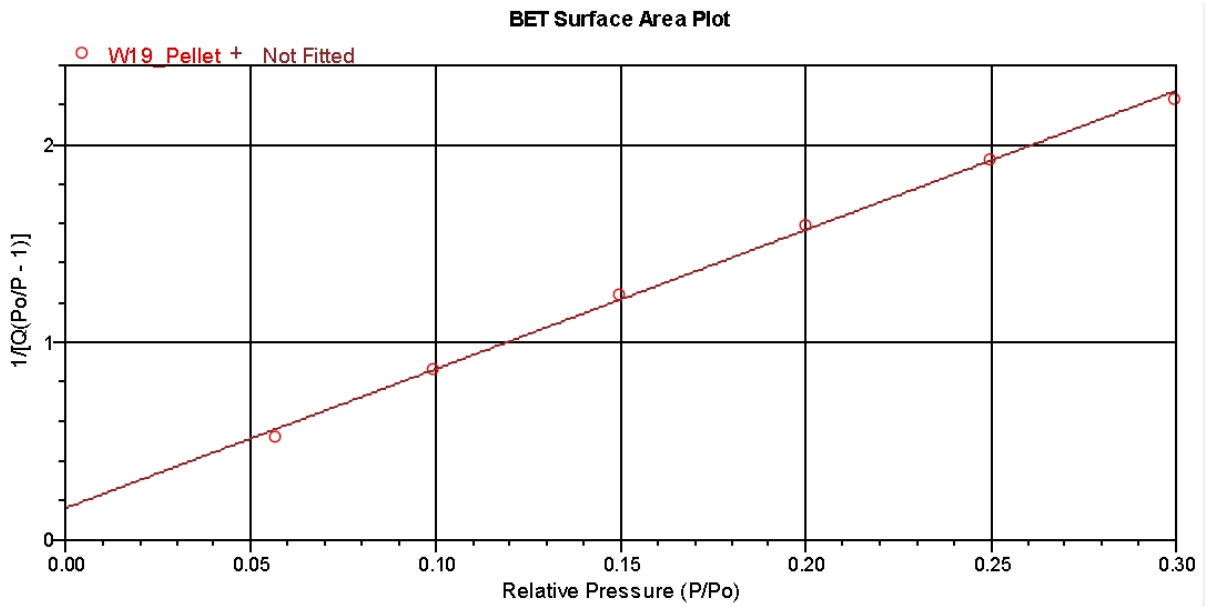
Started: 01.06.2018 13:42:04
Completed: 01.06.2018 15:02:37
Report Time: 01.06.2018 15:04:01
Sample Mass: 3,6051 g
Cold Free Space: 24,2463 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,4917 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.6050 ± 0.0128 m²/g
Slope: 7.034722 ± 0.149649 g/cm³ STP
Y-Intercept: 0.159838 ± 0.029124 g/cm³ STP
C: 45.011588
Qm: 0,1390 cm³/g STP
Correlation Coefficient: 0.9990961
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.056514417	0.1143	0.523992
0.099182085	0.1277	0.862282
0.149675714	0.1420	1.239967
0.199639833	0.1567	1.591943
0.249569726	0.1730	1.922141
0.299447854	0.1914	2.233509



Sample: W9_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Northe...\W9_Pellet.SMP

Started: 01.06.2018 13:42:04
Completed: 01.06.2018 15:02:37
Report Time: 01.06.2018 15:03:39
Sample Mass: 4,0453 g
Cold Free Space: 24,6300 cm³
Low Pressure Dose: None
Automatic Degas: No

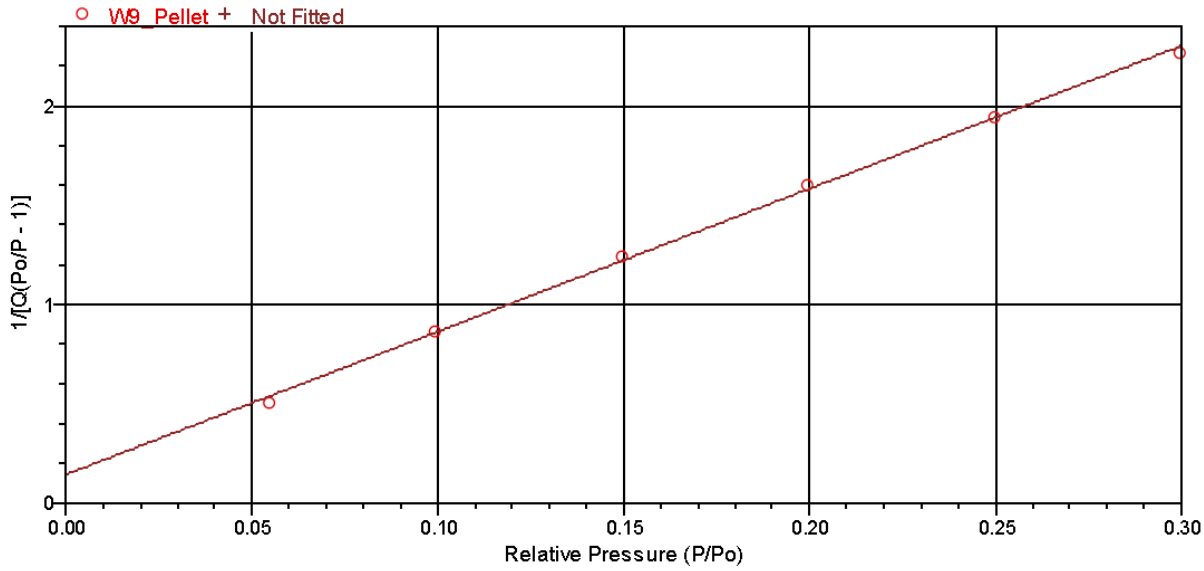
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,6278 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.5932 ± 0.0107 m²/g
Slope: 7.194303 ± 0.130442 g/cm³ STP
Y-Intercept: 0.142731 ± 0.025364 g/cm³ STP
C: 51.404671
Qm: 0,1363 cm³/g STP
Correlation Coefficient: 0.9993432
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054509264	0.1141	0.505352
0.099010989	0.1278	0.860120
0.149614548	0.1416	1.242835
0.199555199	0.1556	1.602017
0.249508443	0.1710	1.943856
0.299360513	0.1884	2.267439

BET Surface Area Plot



Sample: W10_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\North...\W10_Pellet.SMP

Started: 01.06.2018 15:13:14
Completed: 01.06.2018 16:34:59
Report Time: 01.06.2018 16:36:59
Sample Mass: 3,7132 g
Cold Free Space: 24,6333 cm³
Low Pressure Dose: None
Automatic Degas: No

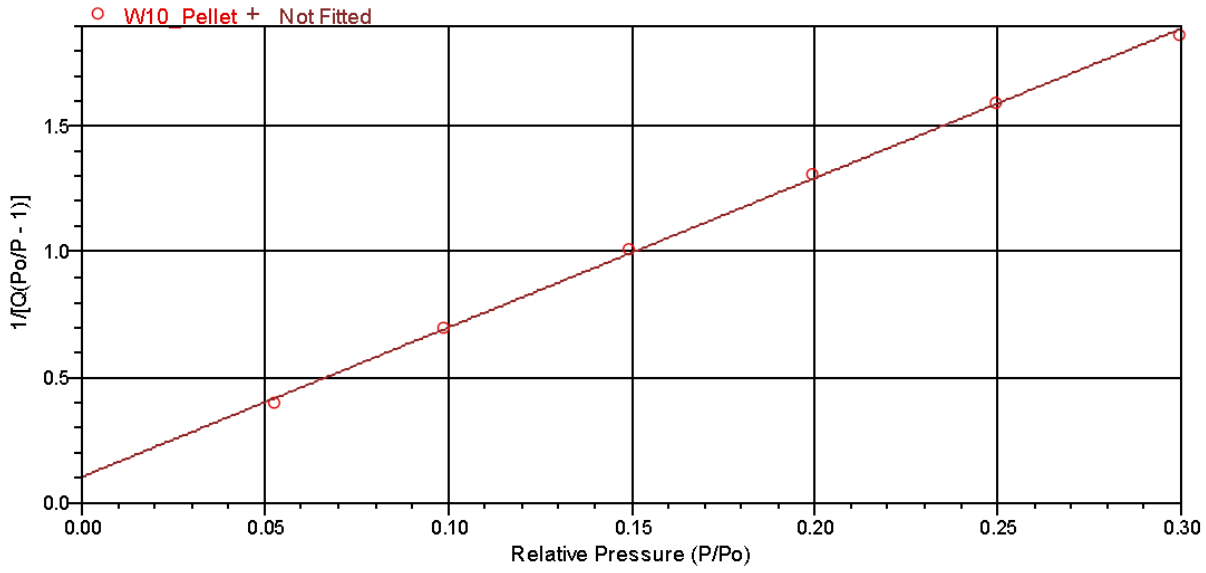
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,6482 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.7185 ± 0.0104 m²/g
Slope: 5.954554 ± 0.086138 g/cm³ STP
Y-Intercept: 0.102903 ± 0.016735 g/cm³ STP
C: 58.865811
Qm: 0,1651 cm³/g STP
Correlation Coefficient: 0.9995817
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.052495295	0.1402	0.395221
0.098782244	0.1576	0.695591
0.149508942	0.1741	1.009624
0.199514330	0.1909	1.305825
0.249398695	0.2088	1.590956
0.299338716	0.2289	1.866755

BET Surface Area Plot



Sample: W27_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\North...\W27_Pellet.SMP

Started: 04.06.2018 13:26:43
Completed: 04.06.2018 14:51:32
Report Time: 04.06.2018 15:12:29
Sample Mass: 3,7815 g
Cold Free Space: 24,7260 cm³
Low Pressure Dose: None
Automatic Degas: No

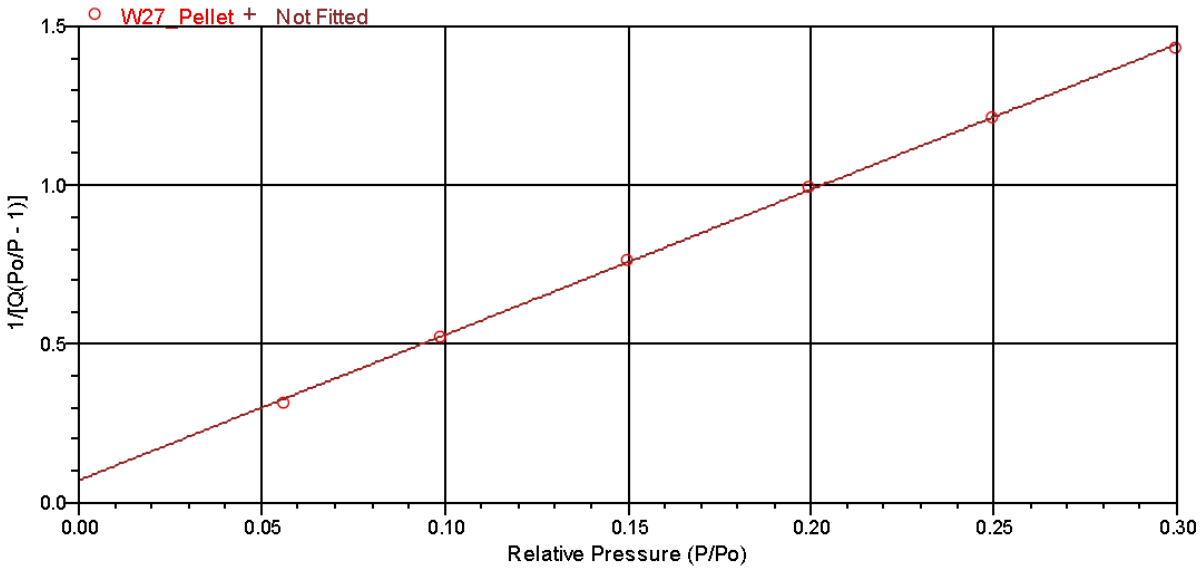
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,6718 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.9363 ± 0.0099 m²/g
Slope: 4.578834 ± 0.048096 g/cm³ STP
Y-Intercept: 0.070022 ± 0.009358 g/cm³ STP
C: 66.391172
Qm: 0,2151 cm³/g STP
Correlation Coefficient: 0.9997794
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.056089578	0.1883	0.315590
0.098811438	0.2090	0.524719
0.149648024	0.2302	0.764366
0.199550580	0.2513	0.992085
0.249603405	0.2739	1.214594
0.299543403	0.2988	1.431419

BET Surface Area Plot



Sample: W18_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\North...\W18_Pellet.SMP

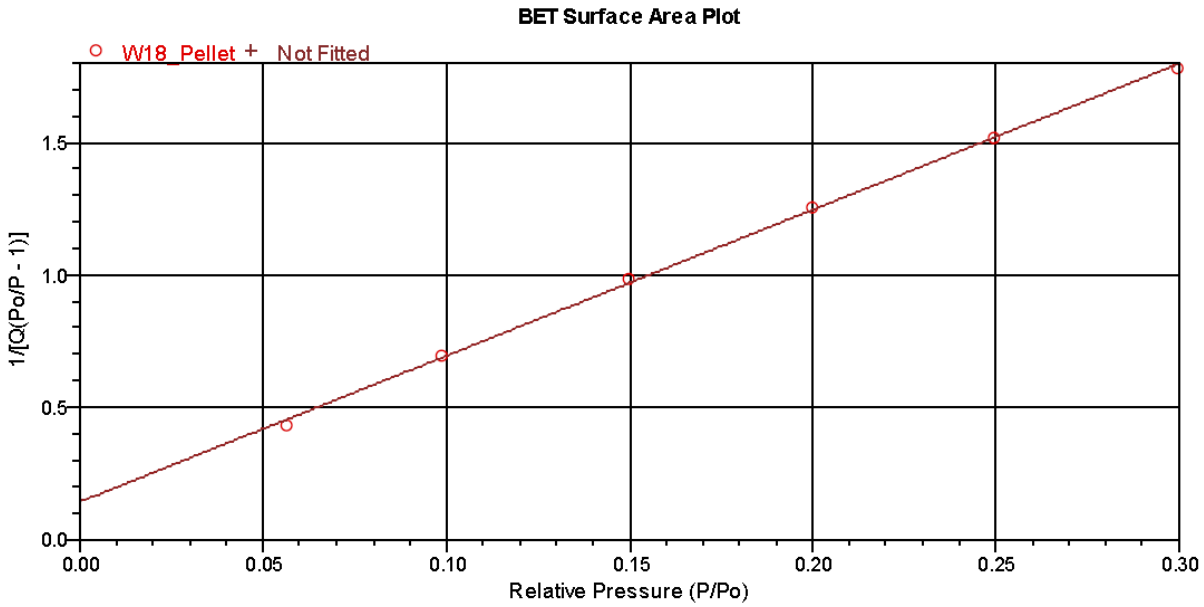
Started: 04.06.2018 13:26:43
Completed: 04.06.2018 14:51:33
Report Time: 04.06.2018 15:12:13
Sample Mass: 3,8331 g
Cold Free Space: 24,9888 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,7626 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.7694 ± 0.0116 m²/g
Slope: 5.514518 ± 0.083556 g/cm³ STP
Y-Intercept: 0.142372 ± 0.016259 g/cm³ STP
C: 39.733243
Qm: 0,1768 cm³/g STP
Correlation Coefficient: 0.9995411
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.056495928	0.1382	0.433308
0.098709268	0.1582	0.692190
0.149595096	0.1788	0.984044
0.199633642	0.1985	1.256746
0.249556832	0.2188	1.519597
0.299545790	0.2405	1.778091



Sample: W15_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\North...\W15_Pellet.SMP

Started: 04.06.2018 15:26:26
Completed: 04.06.2018 16:50:21
Report Time: 04.06.2018 16:50:43
Sample Mass: 3,3103 g
Cold Free Space: 26,0453 cm³
Low Pressure Dose: None
Automatic Degas: No

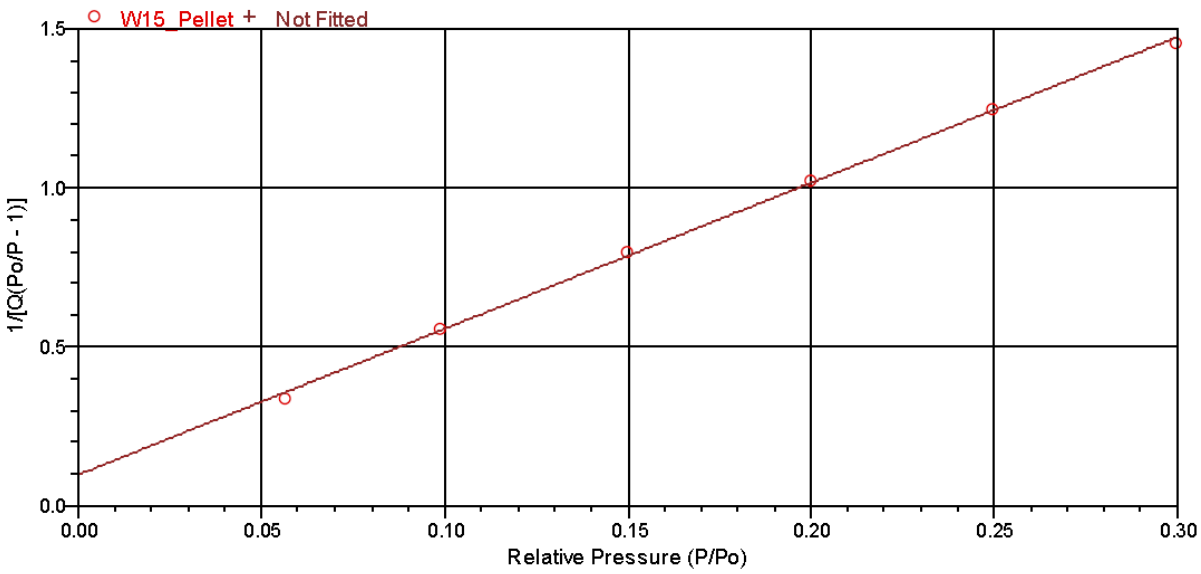
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,0188 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.9286 ± 0.0141 m²/g
Slope: 4.589888 ± 0.069641 g/cm³ STP
Y-Intercept: 0.097311 ± 0.013550 g/cm³ STP
C: 48.167122
Qm: 0,2133 cm³/g STP
Correlation Coefficient: 0.9995399
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.056395853	0.1760	0.339521
0.098881629	0.1977	0.554968
0.149576948	0.2206	0.797274
0.199627351	0.2433	1.025270
0.249566902	0.2671	1.244861
0.299485119	0.2933	1.457575

BET Surface Area Plot



Sample: W16_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\North...\W16_Pellet.SMP

Started: 01.06.2018 13:42:04
Completed: 01.06.2018 15:02:37
Report Time: 01.06.2018 15:03:50
Sample Mass: 3,3436 g
Cold Free Space: 25,0629 cm³
Low Pressure Dose: None
Automatic Degas: No

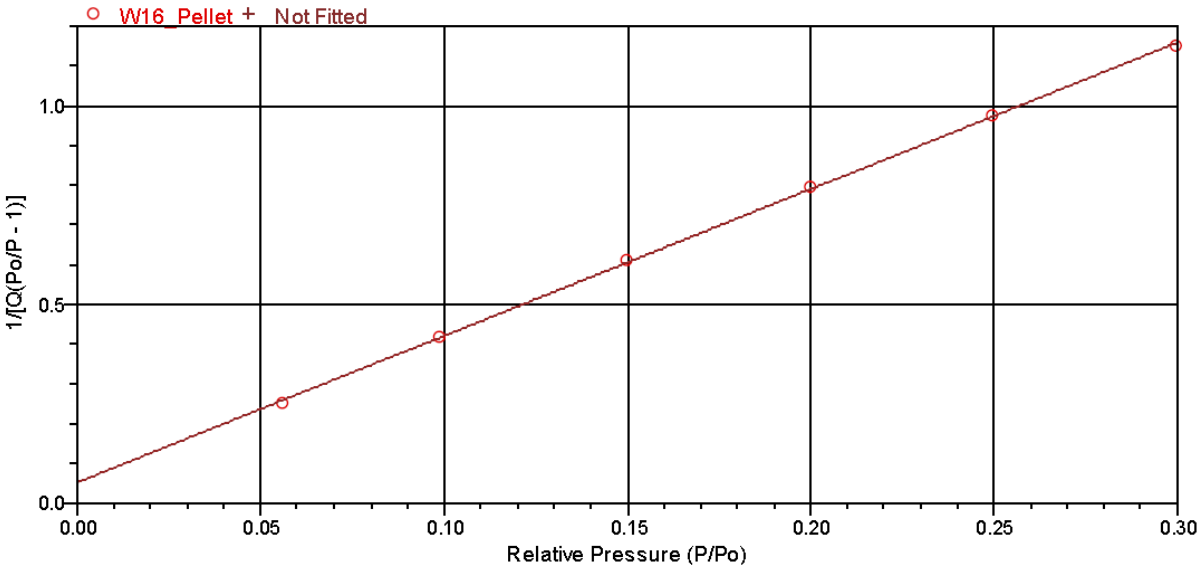
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,7026 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.1634 ± 0.0115 m²/g
Slope: 3.689709 ± 0.036450 g/cm³ STP
Y-Intercept: 0.051457 ± 0.007091 g/cm³ STP
C: 72.704412
Qm: 0,2673 cm³/g STP
Correlation Coefficient: 0.9998049
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055929679	0.2374	0.249559
0.098755545	0.2626	0.417306
0.149585768	0.2885	0.609794
0.199621735	0.3138	0.794687
0.249513747	0.3414	0.973879
0.299489344	0.3723	1.148399

BET Surface Area Plot



Sample: W20_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\North...\W20_Pellet.SMP

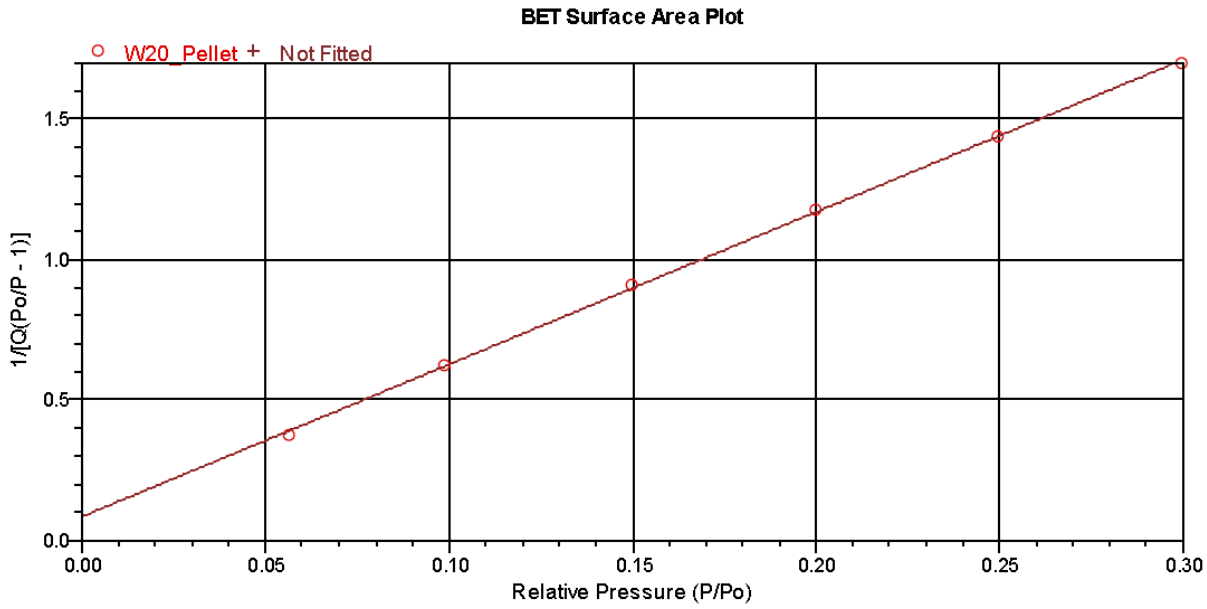
Started: 04.06.2018 15:26:26
Completed: 04.06.2018 16:50:21
Report Time: 04.06.2018 16:50:54
Sample Mass: 3,8127 g
Cold Free Space: 23,5727 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,3266 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.7895 ± 0.0086 m²/g
Slope: 5.429000 ± 0.059170 g/cm³ STP
Y-Intercept: 0.084118 ± 0.011517 g/cm³ STP
C: 65.540543
Qm: 0,1814 cm³/g STP
Correlation Coefficient: 0.9997625
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.056380935	0.1587	0.376597
0.098943268	0.1760	0.623775
0.149678025	0.1940	0.907563
0.199711307	0.2116	1.179137
0.249670914	0.2308	1.441743
0.299523063	0.2519	1.697553



E. BET Report for Bolivia Samples

Catavi Formation

Sample: 01CV1
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\01CV1.SMP

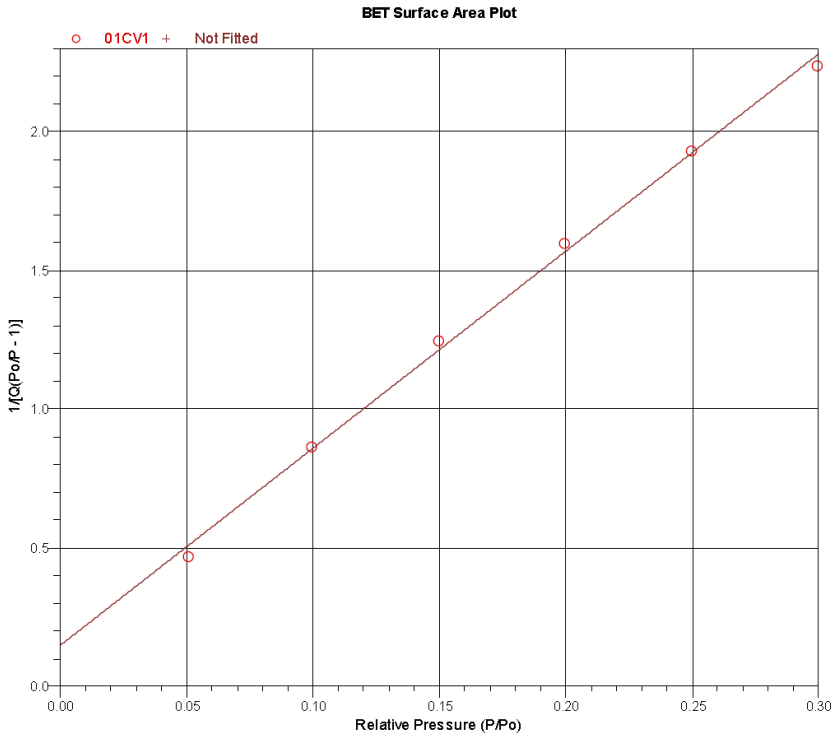
Started: 08.03.2018 11:55:51
Completed: 08.03.2018 13:30:23
Report Time: 08.03.2018 13:32:42
Sample Mass: 2,0962 g
Cold Free Space: 26,9838 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2959 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.5997 ± 0.0148 m²/g
Slope: 7.110794 ± 0.176048 g/cm³ STP
Y-Intercept: 0.146842 ± 0.034235 g/cm³ STP
C: 49.424745
Qm: 0,1378 cm³/g STP
Correlation Coefficient: 0.9987763
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.050693670	0.1144	0.466658
0.099508060	0.1281	0.862681
0.149744458	0.1415	1.245064
0.199729795	0.1562	1.598060
0.249655868	0.1725	1.929374
0.299639607	0.1911	2.238235



Sample: 02CV2
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\02CV2.SMP

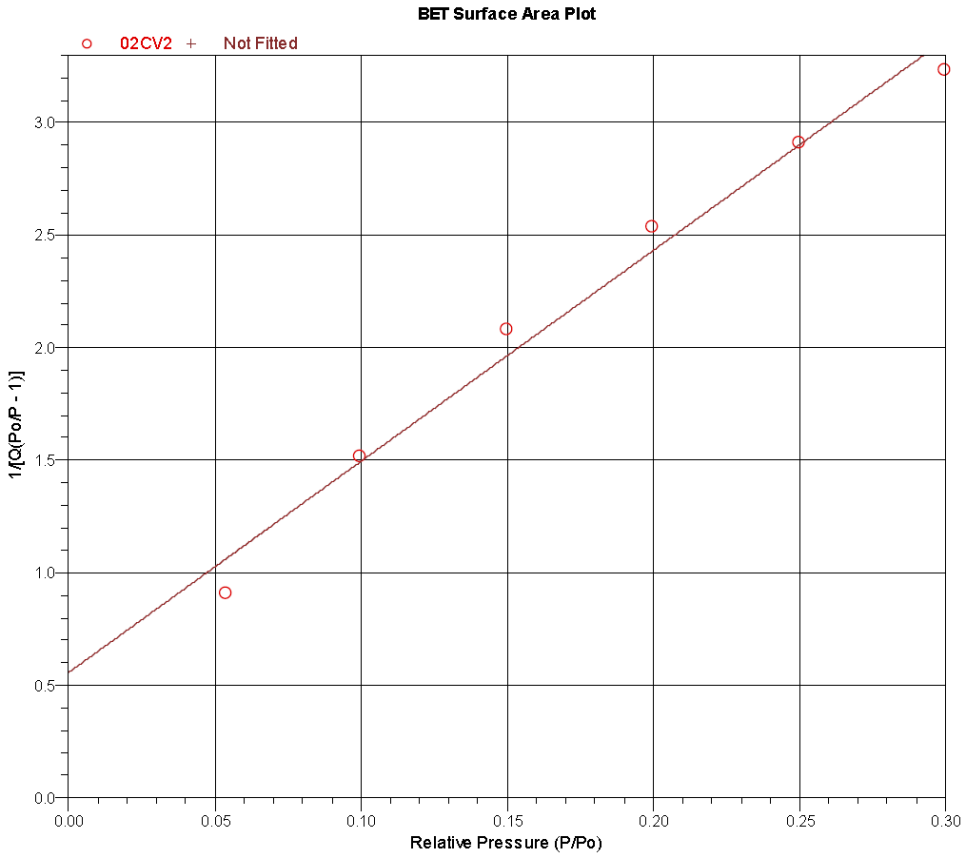
Started: 08.03.2018 11:55:51
Completed: 08.03.2018 13:30:23
Report Time: 08.03.2018 13:32:54
Sample Mass: 2,0617 g
Cold Free Space: 26,7750 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2245 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.4383 ± 0.0280 m²/g
Slope: 9.373886 ± 0.623122 g/cm³ STP
Y-Intercept: 0.557058 ± 0.121213 g/cm³ STP
C: 17.827478
Qm: 0,1007 cm³/g STP
Correlation Coefficient: 0.9912778
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.053579858	0.0621	0.911906
0.099553539	0.0726	1.522963
0.149719326	0.0846	2.081053
0.199658945	0.0983	2.538244
0.249574612	0.1143	2.910850
0.299489238	0.1322	3.234683



Sample: 03CV3
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\03CV3.SMP

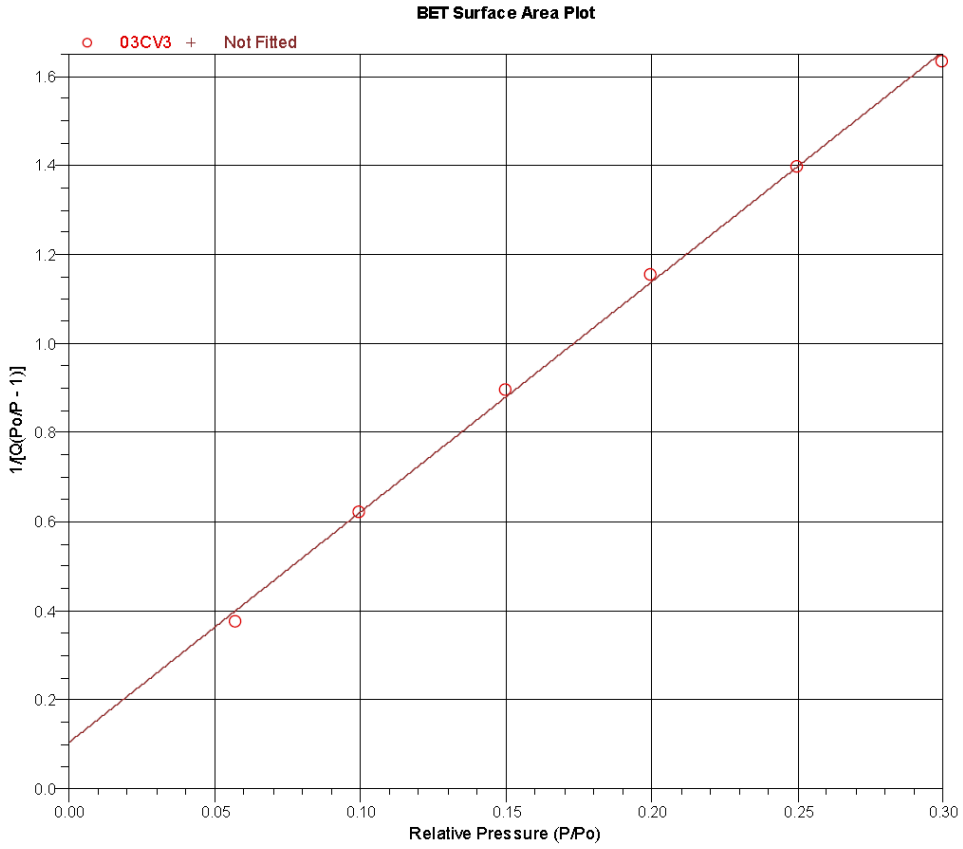
Started: 08.03.2018 11:55:51
Completed: 08.03.2018 13:30:23
Report Time: 08.03.2018 13:33:05
Sample Mass: 2,0747 g
Cold Free Space: 27,3899 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,4268 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.8248 ± 0.0151 m²/g
Slope: 5.173307 ± 0.095016 g/cm³ STP
Y-Intercept: 0.103967 ± 0.018503 g/cm³ STP
C: 50.759256
Qm: 0,1895 cm³/g STP
Correlation Coefficient: 0.9993260
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.056847721	0.1603	0.376125
0.099486432	0.1775	0.622471
0.149699031	0.1964	0.896442
0.199675375	0.2162	1.154106
0.249661585	0.2380	1.398311
0.299661875	0.2618	1.634349



Copacabana Formation

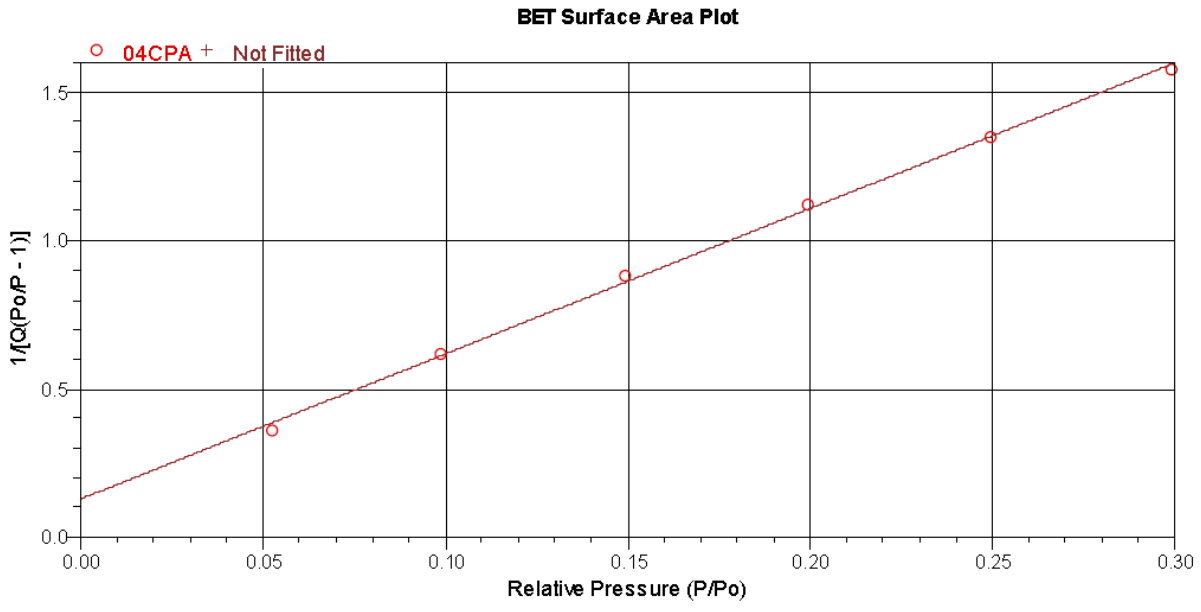
Sample: 04CPA
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\sandstone\04CPA-2.SMP

Started:	30.04.2018 14:20:17	Analysis Adsorptive:	N2
Completed:	30.04.2018 16:32:10	Analysis Bath Temp.:	-195,850 °C
Report Time:	30.04.2018 16:32:28	Thermal Correction:	No
Sample Mass:	2,8315 g	Warm Free Space:	8,8645 cm³ Measured
Cold Free Space:	25,4415 cm³	Equilibration Interval:	10 s
Low Pressure Dose:	None	Sample Density:	1,000 g/cm³
Automatic Degas:	No		

BET Report

BET Surface Area: 0.8654 ± 0.0176 m²/g
Slope: 4.901539 ± 0.100438 g/cm³ STP
Y-Intercept: 0.127773 ± 0.019501 g/cm³ STP
C: 39.361227
Qm: 0,1988 cm³/g STP
Correlation Coefficient: 0.9991613
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.052625830	0.1541	0.360529
0.098628061	0.1768	0.619006
0.149340605	0.1995	0.879817
0.199337778	0.2221	1.120892
0.249240866	0.2459	1.350204
0.299232099	0.2711	1.574990



Sample: 05CPL
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\05CPL-2.SMP

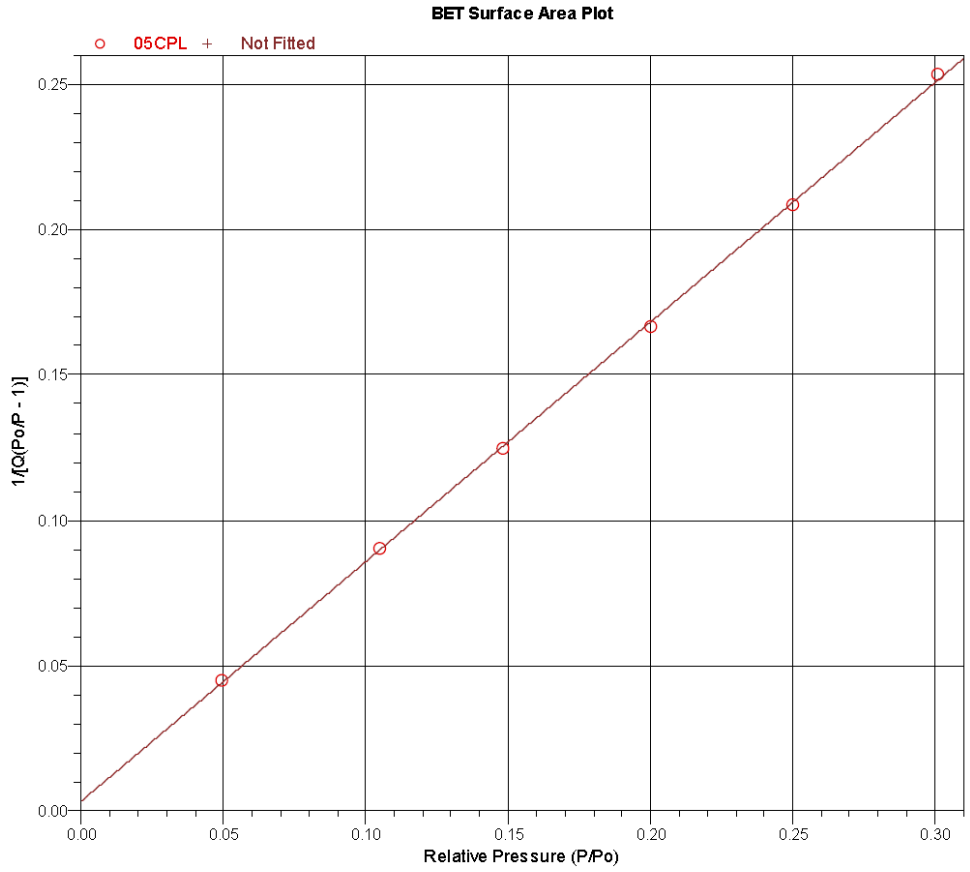
Started: 26.03.2018 20:12:10
Completed: 26.03.2018 21:57:14
Report Time: 26.03.2018 21:58:32
Sample Mass: 2,7971 g
Cold Free Space: 26,1715 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,1018 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 5.2564 ± 0.0413 m²/g
Slope: 0.824754 ± 0.006392 g/cm³ STP
Y-Intercept: 0.003304 ± 0.001247 g/cm³ STP
C: 250.619096
Qm: 1,2076 cm³/g STP
Correlation Coefficient: 0.9998799
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.049330102	1.1563	0.044878
0.105086935	1.3005	0.090294
0.148150829	1.3933	0.124826
0.199860691	1.4976	0.166790
0.250155336	1.5987	0.208677
0.300959995	1.6999	0.253273



Cumaná Formation

Sample: 06CM
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\06CM.SMP

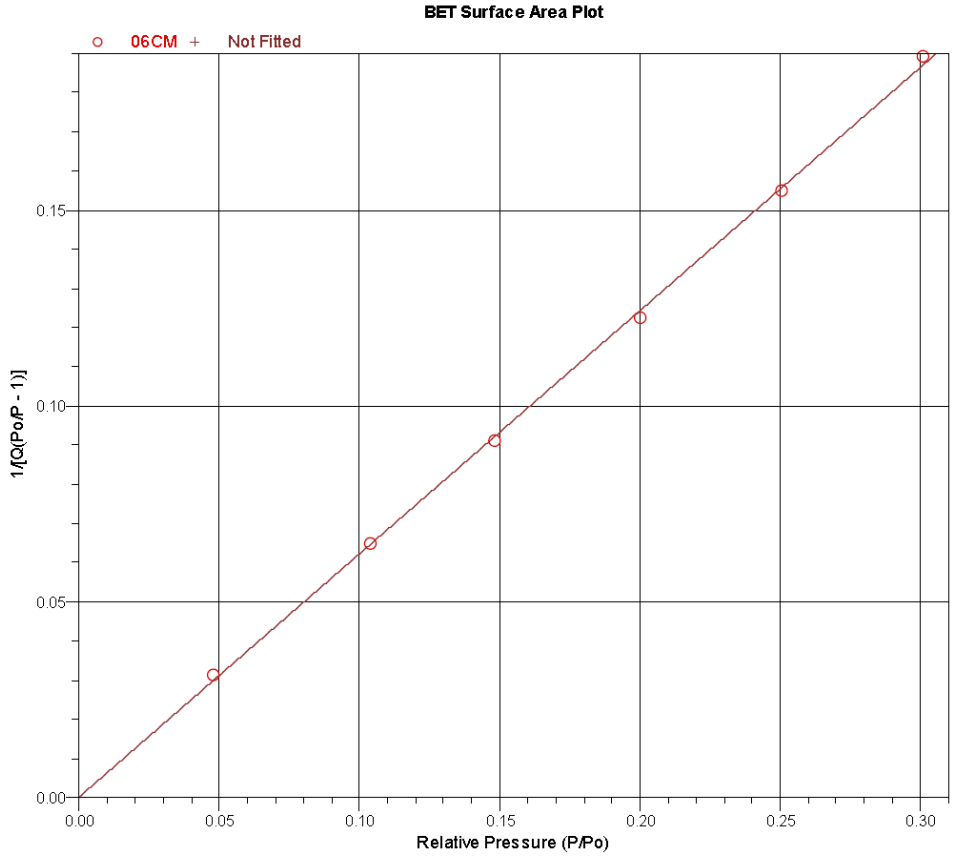
Started: 08.03.2018 13:42:05
Completed: 08.03.2018 15:25:21
Report Time: 08.03.2018 15:27:51
Sample Mass: 2,0378 g
Cold Free Space: 26,0967 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,0442 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 7.0066 ± 0.0884 m²/g
Slope: 0.621028 ± 0.007691 g/cm³ STP
Y-Intercept: 0.000181 ± 0.001500 g/cm³ STP
C: 3437.484794
Qm: 1,6098 cm³/g STP
Correlation Coefficient: 0.9996934
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.047643494	1.6018	0.031232
0.104015244	1.7926	0.064762
0.148211704	1.9095	0.091121
0.199824849	2.0355	0.122687
0.250227266	2.1556	0.154827
0.301046911	2.2772	0.189137



Uncía Formation

Sample: 08UN
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\sandstone\08UN.SMP

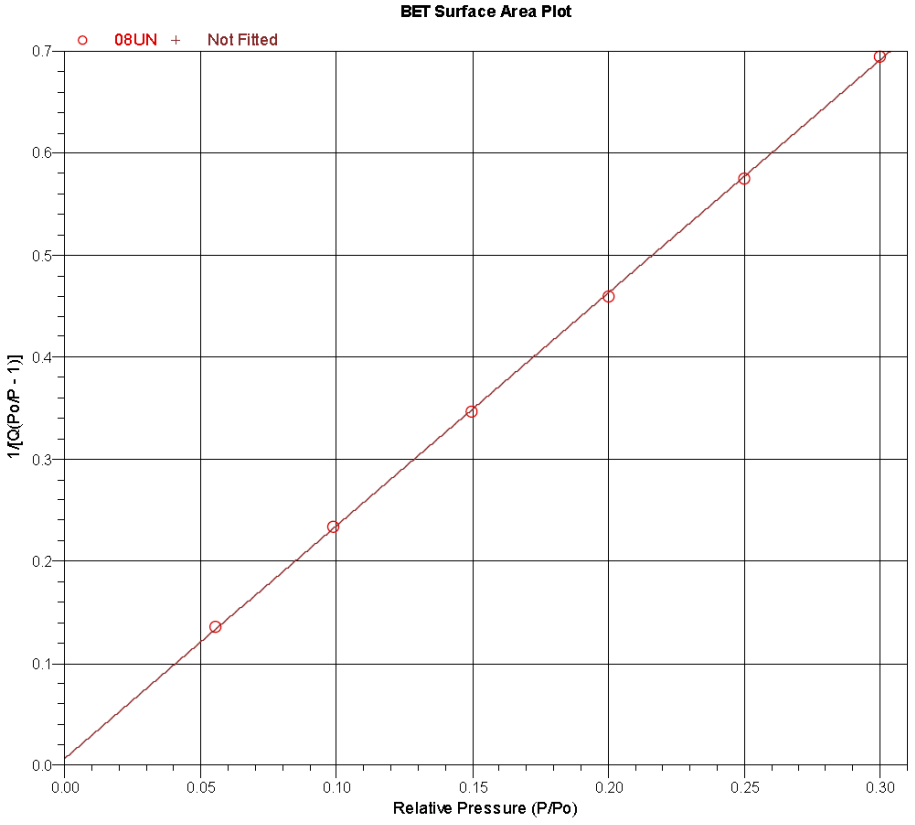
Started: 09.03.2018 12:02:35
Completed: 09.03.2018 14:05:31
Report Time: 09.03.2018 14:09:28
Sample Mass: 2,0210 g
Cold Free Space: 26,0368 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,0196 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.9016 ± 0.0113 m²/g
Slope: 2.282327 ± 0.013388 g/cm³ STP
Y-Intercept: 0.006590 ± 0.002609 g/cm³ STP
C: 347.342664
Qm: 0,4369 cm³/g STP
Correlation Coefficient: 0.9999312
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055546122	0.4345	0.135372
0.099047260	0.4712	0.233305
0.149809266	0.5081	0.346808
0.199866353	0.5432	0.459893
0.249937778	0.5791	0.575401
0.300161833	0.6170	0.695174



Belén Formation

Sample: 09BE
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\09BE-2.SMP

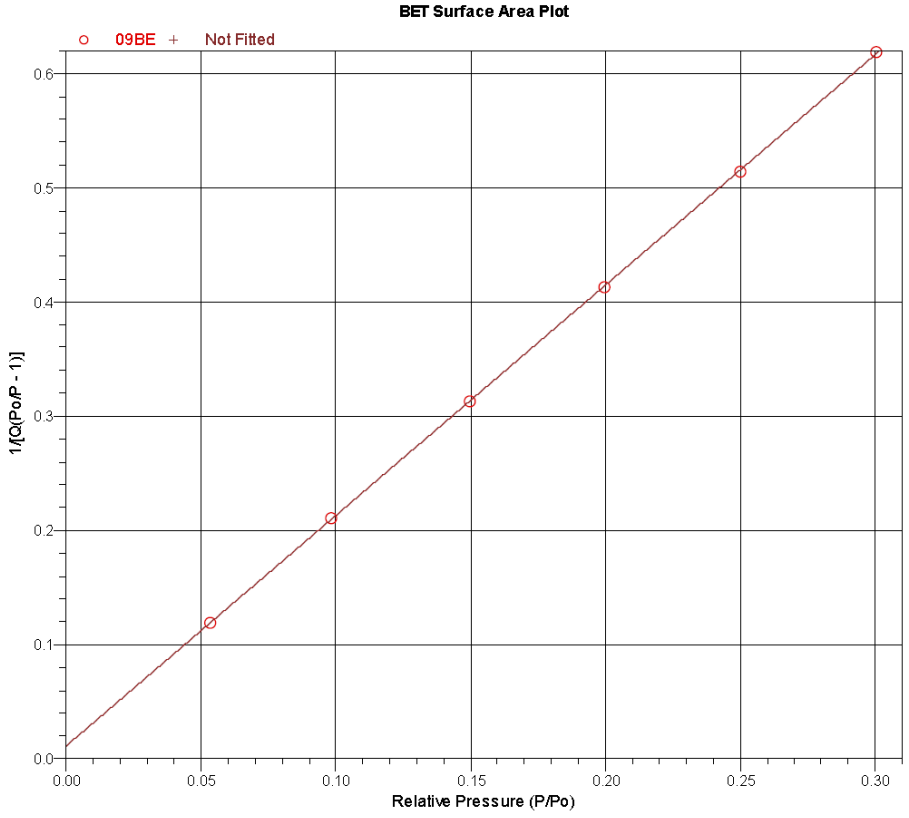
Started: 26.03.2018 20:12:10
Completed: 26.03.2018 21:57:15
Report Time: 26.03.2018 21:58:43
Sample Mass: 2,5214 g
Cold Free Space: 26,6381 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,1991 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.1450 ± 0.0086 m²/g
Slope: 2.018048 ± 0.007988 g/cm³ STP
Y-Intercept: 0.011166 ± 0.001556 g/cm³ STP
C: 181.734387
Qm: 0,4928 cm³/g STP
Correlation Coefficient: 0.9999687
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.053365089	0.4717	0.119515
0.098540593	0.5185	0.210841
0.149818683	0.5632	0.312904
0.199852394	0.6050	0.412852
0.249952971	0.6482	0.514140
0.300221495	0.6928	0.619227



Cancañiri Formation

Sample: 10CNC
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\10CNC.SMP

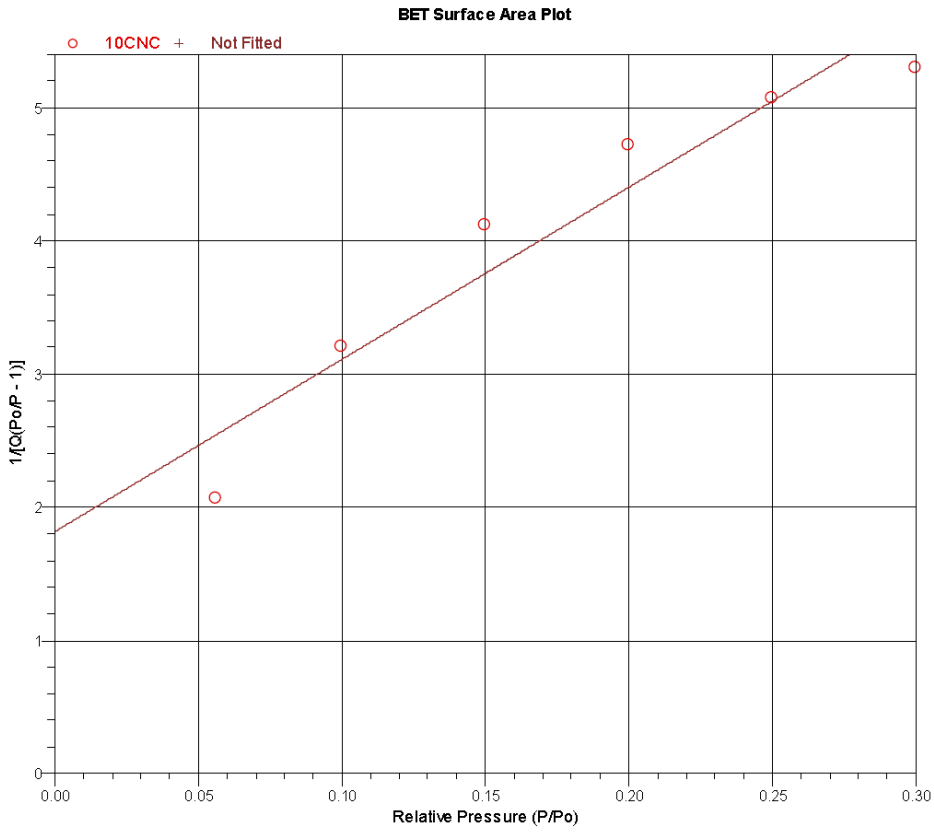
Started: 08.03.2018 13:42:05
Completed: 08.03.2018 15:25:20
Report Time: 08.03.2018 15:28:03
Sample Mass: 2,0966 g
Cold Free Space: 26,8051 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2695 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.2951 ± 0.0391 m²/g
Slope: 12.934019 ± 1.920513 g/cm³ STP
Y-Intercept: 1.815537 ± 0.373732 g/cm³ STP
C: 8.124073
Qm: 0,0678 cm³/g STP
Correlation Coefficient: 0.9586218
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055870783	0.0285	2.077479
0.099662685	0.0344	3.213776
0.149687676	0.0427	4.123783
0.199645340	0.0528	4.727113
0.249522433	0.0655	5.079128
0.299391254	0.0806	5.301557



Tiquina Formation

Sample: 11TQ
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\11TQ.SMP

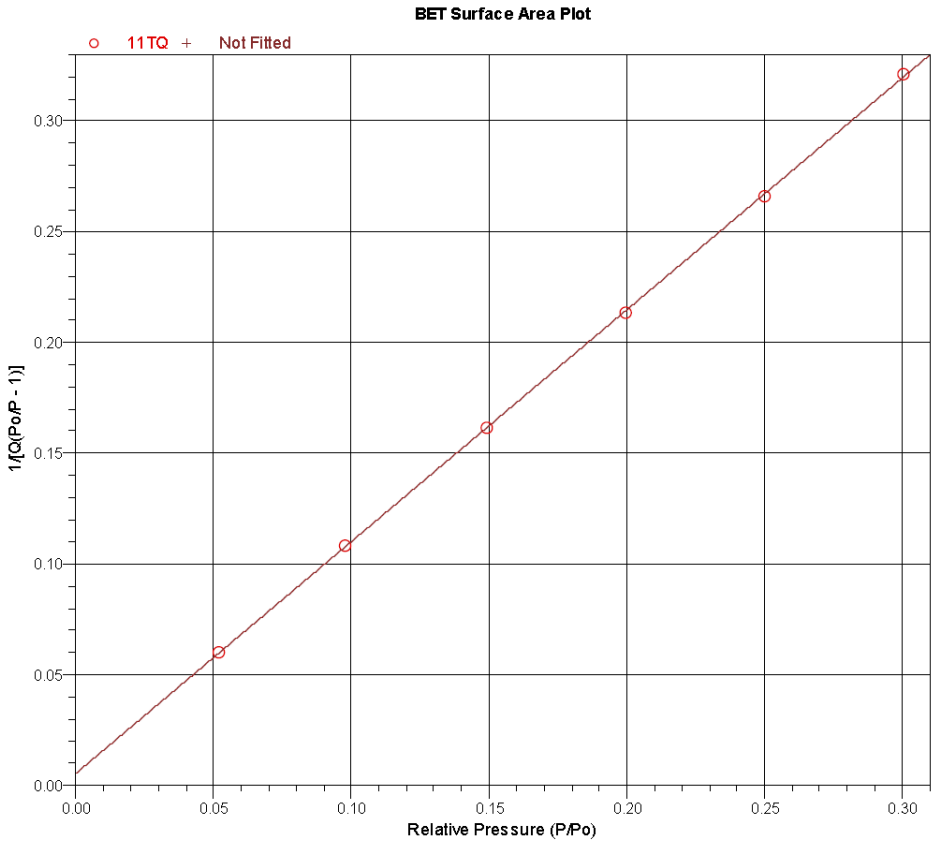
Started: 08.03.2018 13:42:05
Completed: 08.03.2018 15:25:21
Report Time: 08.03.2018 15:28:13
Sample Mass: 2,0736 g
Cold Free Space: 27,4322 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3795 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 4.1357 ± 0.0175 m²/g
Slope: 1.047004 ± 0.004383 g/cm³ STP
Y-Intercept: 0.005434 ± 0.000852 g/cm³ STP
C: 193.677171
Qm: 0,9502 cm³/g STP
Correlation Coefficient: 0.9999649
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.051797619	0.9095	0.060060
0.097616451	1.0010	0.108069
0.149377081	1.0875	0.161481
0.199618753	1.1682	0.213490
0.249865072	1.2508	0.266308
0.300165001	1.3365	0.320916



Copacabana Formation

Sample: 12CPA2
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\sandstone\12CPA2-2.SMP

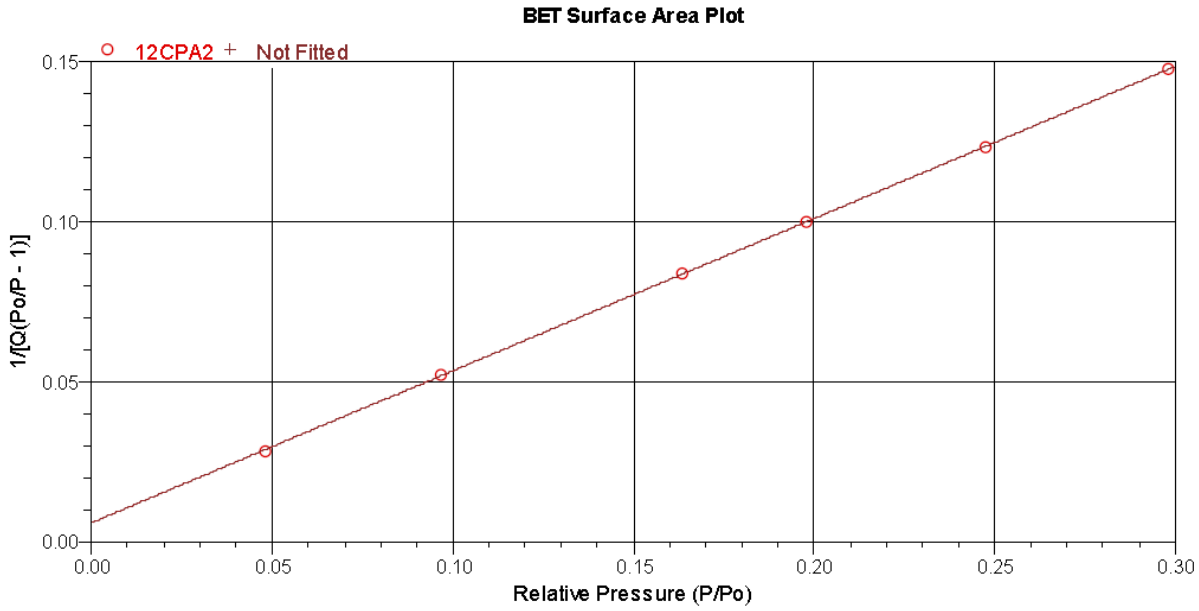
Started: 30.04.2018 19:12:51
Completed: 30.04.2018 21:04:50
Report Time: 30.04.2018 21:05:31
Sample Mass: 2,6005 g
Cold Free Space: 26,1407 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,0081 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 9.0423 ± 0.0481 m²/g
Slope: 0.475378 ± 0.002515 g/cm³ STP
Y-Intercept: 0.005982 ± 0.000490 g/cm³ STP
C: 80.473566
Qm: 2,0775 cm³/g STP
Correlation Coefficient: 0.9999440
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.048266885	1.7943	0.028264
0.096674955	2.0393	0.052478
0.163412932	2.3217	0.084134
0.198052106	2.4637	0.100243
0.247450485	2.6675	0.123266
0.298133430	2.8779	0.147597



Aranjuéz Formation

Sample: 13AR
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\sandstone\13AR-2.SMP

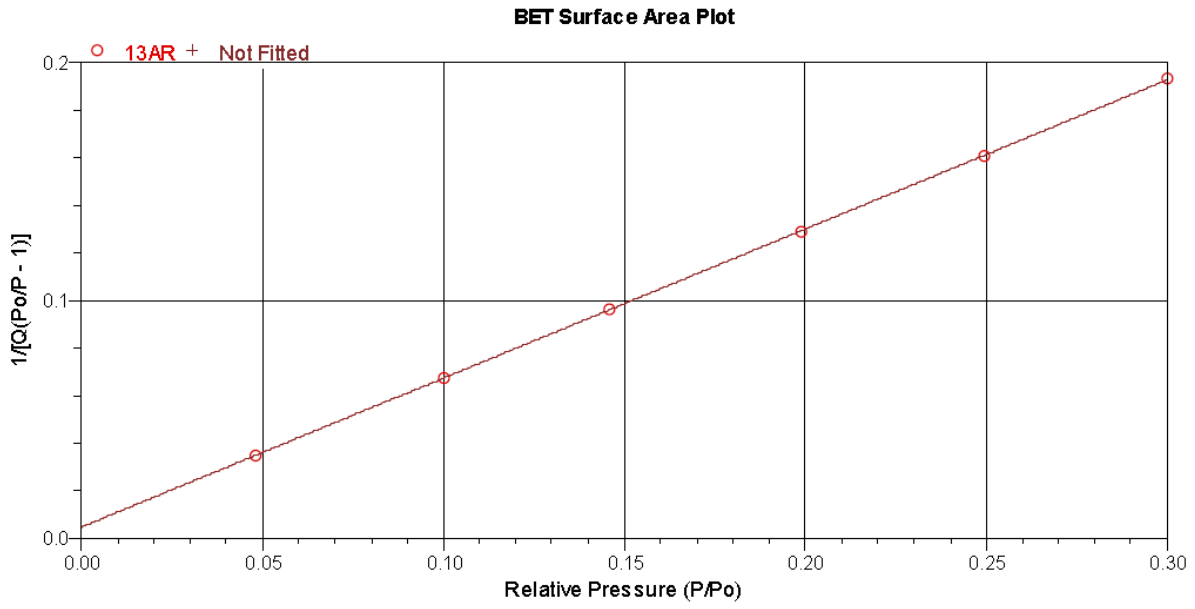
Started: 30.04.2018 14:20:17
Completed: 30.04.2018 16:32:10
Report Time: 30.04.2018 16:32:39
Sample Mass: 3,1628 g
Cold Free Space: 25,7408 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,8949 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 6.8920 ± 0.0212 m²/g
Slope: 0.626840 ± 0.001910 g/cm³ STP
Y-Intercept: 0.004700 ± 0.000370 g/cm³ STP
C: 134.359633
Qm: 1,5834 cm³/g STP
Correlation Coefficient: 0.9999814
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.048115533	1.4572	0.034689
0.099921779	1.6387	0.067744
0.145951392	1.7748	0.096286
0.198970150	1.9240	0.129101
0.249294292	2.0684	0.160552
0.299771510	2.2180	0.193012



Colpacucho Formation

Sample: 14CL
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\sandstone\14CL.SMP

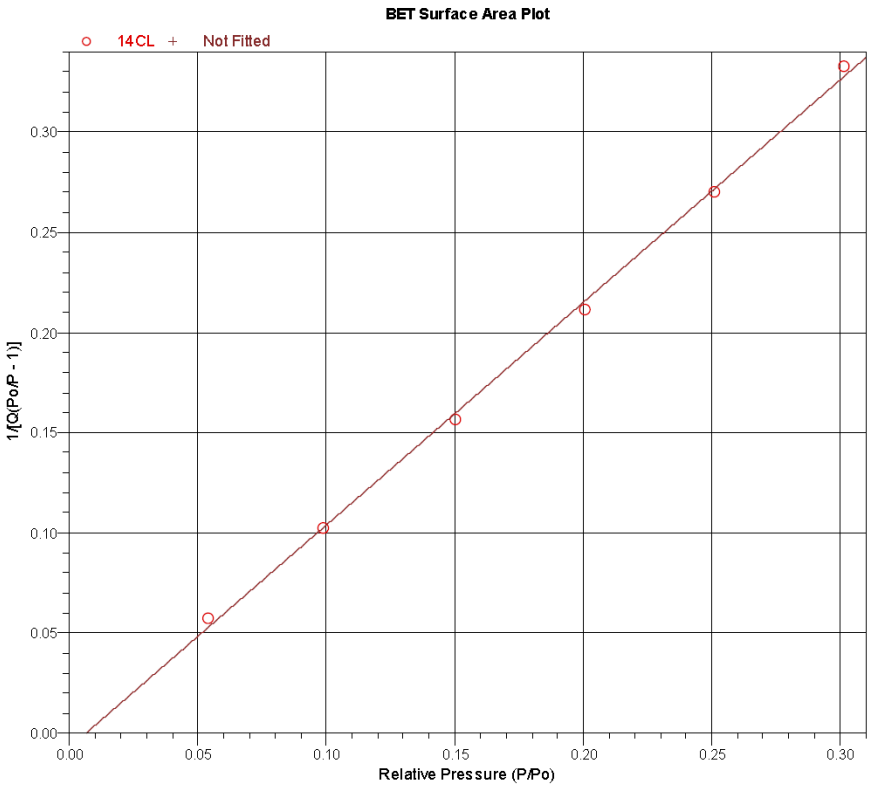
Started: 09.03.2018 12:02:35
Completed: 09.03.2018 14:05:31
Report Time: 09.03.2018 14:09:40
Sample Mass: 2,0347 g
Cold Free Space: 27,6759 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,4625 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.9431 ± 0.0780 m²/g
Slope: 1.110991 ± 0.021425 g/cm³ STP
Y-Intercept: -0.007134 ± 0.004188 g/cm³ STP
C: -154.730272
Qm: 0,9059 cm³/g STP
Correlation Coefficient: 0.9992571
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054048322	0.9982	0.057239
0.098727914	1.0693	0.102439
0.150270436	1.1314	0.156306
0.200593724	1.1872	0.211369
0.251185039	1.2407	0.270359
0.301187062	1.2954	0.332705



Chutani Formation

Sample: 15CHD
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\sandstone\15CHD.SMP

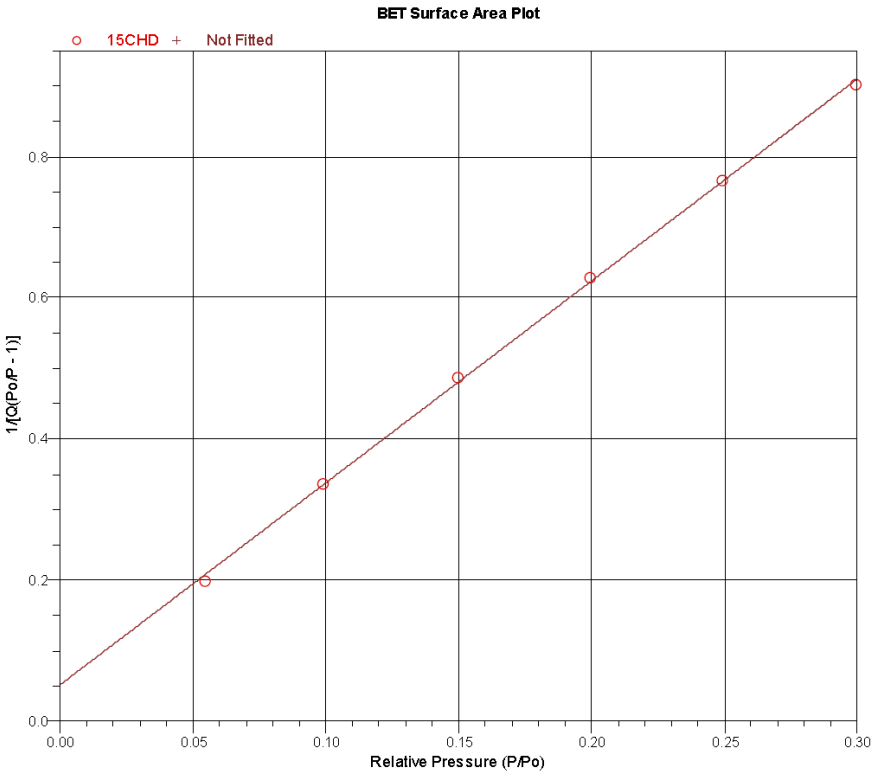
Started: 09.03.2018 14:17:13
Completed: 09.03.2018 15:35:01
Report Time: 09.03.2018 16:34:54
Sample Mass: 2,0547 g
Cold Free Space: 26,8906 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2302 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.4938 ± 0.0180 m²/g
Slope: 2.862495 ± 0.034483 g/cm³ STP
Y-Intercept: 0.051277 ± 0.006706 g/cm³ STP
C: 56.824480
Qm: 0,3432 cm³/g STP
Correlation Coefficient: 0.9997099
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054726333	0.2906	0.199250
0.098840431	0.3257	0.336788
0.149536233	0.3614	0.486469
0.199486209	0.3971	0.627621
0.249488614	0.4343	0.765494
0.299600450	0.4740	0.902462



Sample: 016CHU
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\016CHU-2.SMP

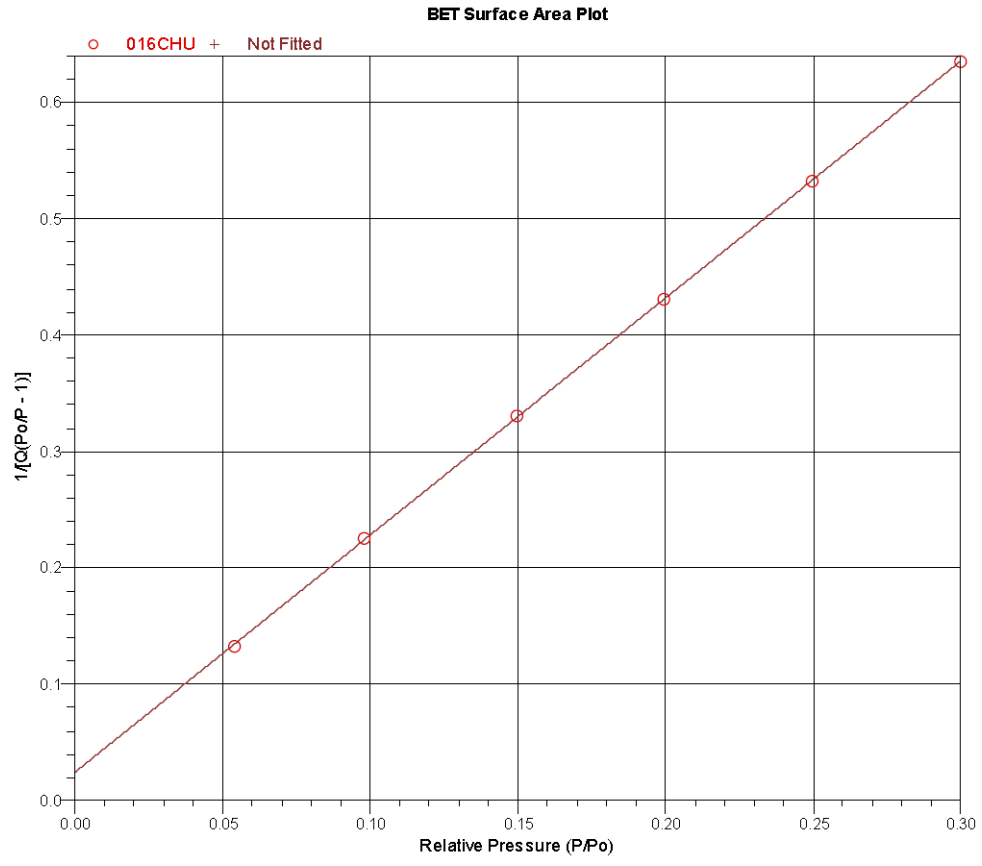
Started: 26.03.2018 20:12:10
Completed: 26.03.2018 21:57:14
Report Time: 26.03.2018 21:58:54
Sample Mass: 2,3716 g
Cold Free Space: 25,8091 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,9565 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.1104 ± 0.0086 m²/g
Slope: 2.038385 ± 0.008225 g/cm³ STP
Y-Intercept: 0.024094 ± 0.001600 g/cm³ STP
C: 85.600657
Qm: 0,4849 cm³/g STP
Correlation Coefficient: 0.9999674
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054271263	0.4330	0.132537
0.098267895	0.4825	0.225839
0.149537976	0.5317	0.330720
0.199596581	0.5782	0.431272
0.249658079	0.6256	0.531834
0.299914320	0.6744	0.635206



Sica-Sica Formation

Sample: 075C
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\sandstone\075C.SMP

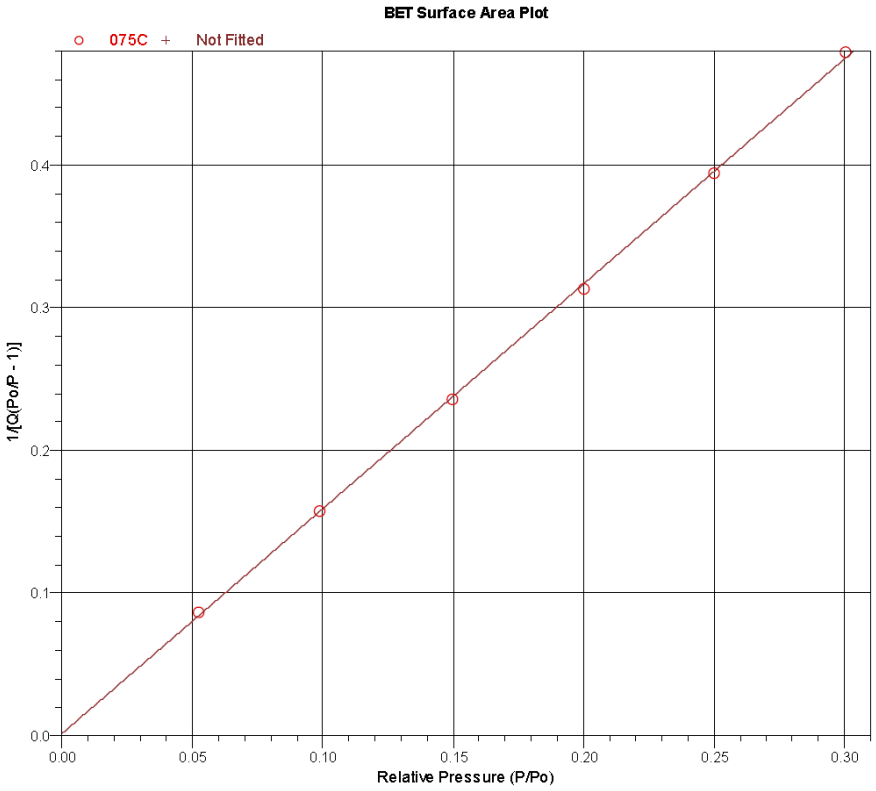
Started: 09.03.2018 12:02:35
Completed: 09.03.2018 14:05:30
Report Time: 09.03.2018 14:09:50
Sample Mass: 2,0485 g
Cold Free Space: 26,8864 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2952 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.7591 ± 0.0268 m²/g
Slope: 1.575962 ± 0.015032 g/cm³ STP
Y-Intercept: 0.001577 ± 0.002930 g/cm³ STP
C: 1000.428128
Qm: 0,6339 cm³/g STP
Correlation Coefficient: 0.9998181
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.052471038	0.6371	0.086919
0.098649983	0.6954	0.157384
0.149861961	0.7484	0.235543
0.200043600	0.7972	0.313699
0.250251023	0.8462	0.394433
0.300621541	0.8969	0.479236



F. BET Report for Spain Samples

Mora Formation

Sample: SAL3
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\SAL3.SMP

Started: 02.05.2018 14:38:57
Completed: 02.05.2018 16:28:54
Report Time: 02.05.2018 16:30:20
Sample Mass: 3,1165 g
Cold Free Space: 24,9566 cm³
Low Pressure Dose: None
Automatic Degas: No

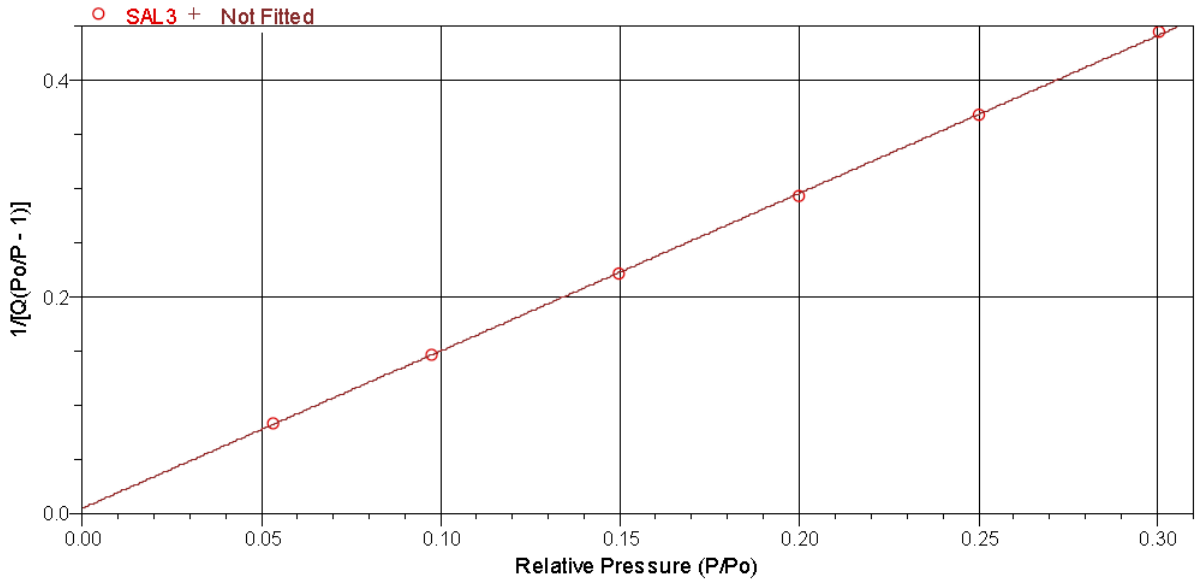
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,7054 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.9821 ± 0.0199 m²/g
Slope: 1.454825 ± 0.009576 g/cm³ STP
Y-Intercept: 0.004766 ± 0.001866 g/cm³ STP
C: 306.237171
Qm: 0,6851 cm³/g STP
Correlation Coefficient: 0.9999134
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.053272842	0.6706	0.083917
0.097559501	0.7354	0.147007
0.149744836	0.7963	0.221172
0.200000434	0.8512	0.293691
0.250306177	0.9073	0.367992
0.300612089	0.9668	0.444562

BET Surface Area Plot



Herrería Formation

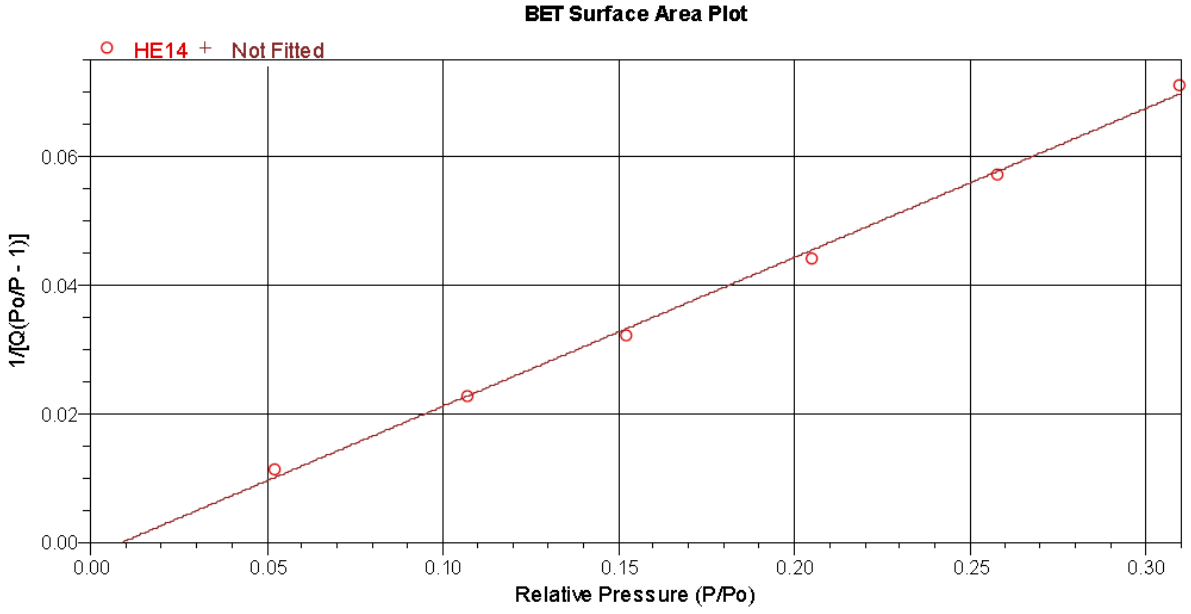
Sample: HE14
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\HE14.SMP

Started:	30.04.2018 16:47:06	Analysis Adsorptive:	N2
Completed:	30.04.2018 18:50:13	Analysis Bath Temp.:	-195,850 °C
Report Time:	30.04.2018 18:51:31	Thermal Correction:	No
Sample Mass:	2,8987 g	Warm Free Space:	9,1003 cm³ Measured
Cold Free Space:	26,1973 cm³	Equilibration Interval:	10 s
Low Pressure Dose:	None	Sample Density:	1,000 g/cm³
Automatic Degas:	No		

BET Report

BET Surface Area: 18.9468 ± 0.4684 m²/g
Slope: 0.231737 ± 0.005568 g/cm³ STP
Y-Intercept: -0.002010 ± 0.001117 g/cm³ STP
C: -114.295830
Qm: 4,3530 cm³/g STP
Correlation Coefficient: 0.9988474
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.052403702	4.8758	0.011342
0.107292098	5.2940	0.022703
0.152117081	5.5453	0.032353
0.204724025	5.8108	0.044301
0.257649535	6.0604	0.057269
0.309239018	6.3016	0.071042



Láncara Formation

Sample: LD
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\LD.SMP

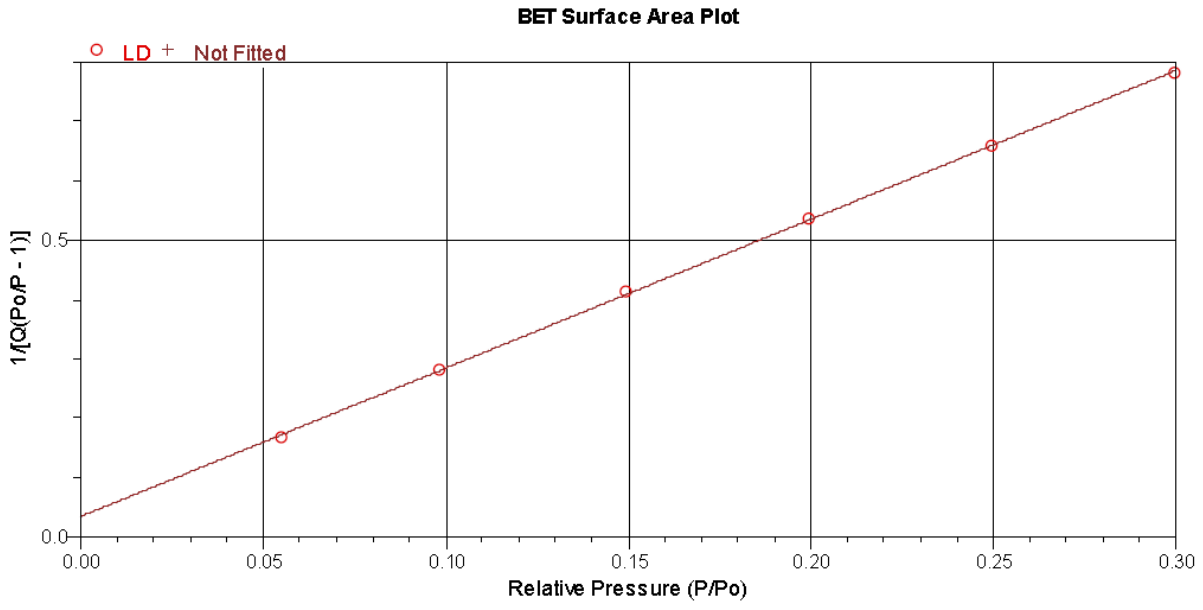
Started: 02.05.2018 14:38:57
Completed: 02.05.2018 16:28:54
Report Time: 02.05.2018 16:29:51
Sample Mass: 3,0240 g
Cold Free Space: 26,3046 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,1252 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.7129 ± 0.0116 m²/g
Slope: 2.507190 ± 0.016856 g/cm³ STP
Y-Intercept: 0.033874 ± 0.003279 g/cm³ STP
C: 75.015696
Qm: 0,3935 cm³/g STP
Correlation Coefficient: 0.9999096
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054806801	0.3476	0.166803
0.098392733	0.3865	0.282335
0.149512040	0.4264	0.412284
0.199567206	0.4647	0.536499
0.249619313	0.5046	0.659304
0.299731269	0.5469	0.782652



Sample: L13
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\L13.SMP

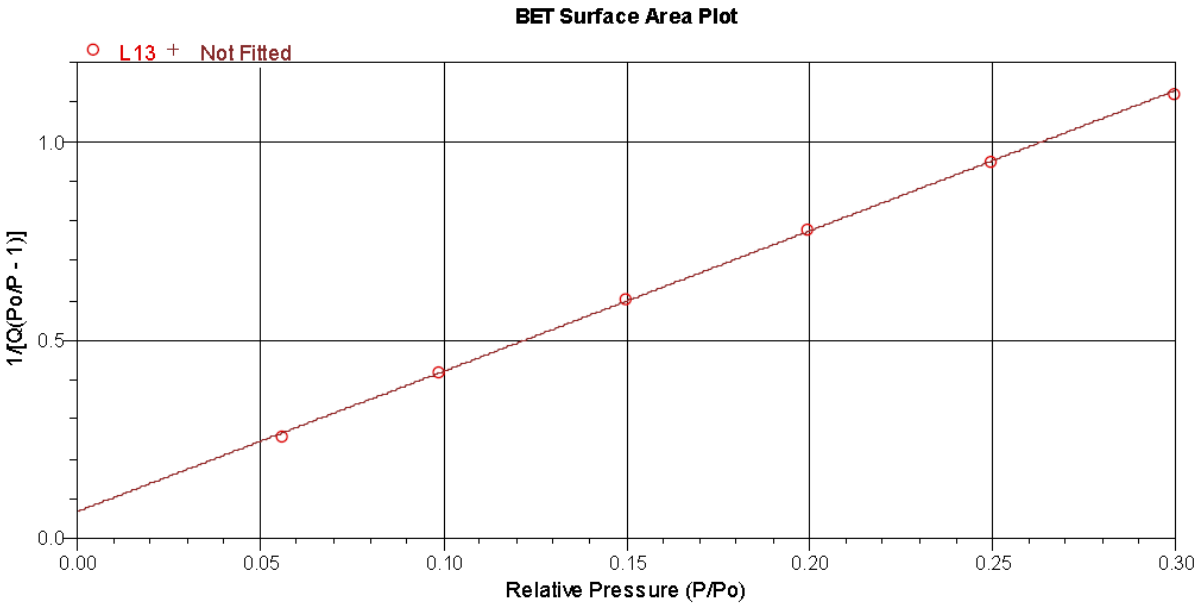
Started: 07.05.2018 15:51:12
Completed: 07.05.2018 17:30:30
Report Time: 07.05.2018 17:31:35
Sample Mass: 3,3242 g
Cold Free Space: 24,1792 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,4639 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.2069 ± 0.0127 m²/g
Slope: 3.539834 ± 0.037374 g/cm³ STP
Y-Intercept: 0.066706 ± 0.007270 g/cm³ STP
C: 54.066573
Qm: 0,2773 cm³/g STP
Correlation Coefficient: 0.9997771
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055863560	0.2320	0.255021
0.098465525	0.2612	0.418106
0.149565779	0.2913	0.603715
0.199515216	0.3200	0.778810
0.249576071	0.3500	0.950254
0.299548353	0.3818	1.120125



Sample: G18
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\G18.SMP

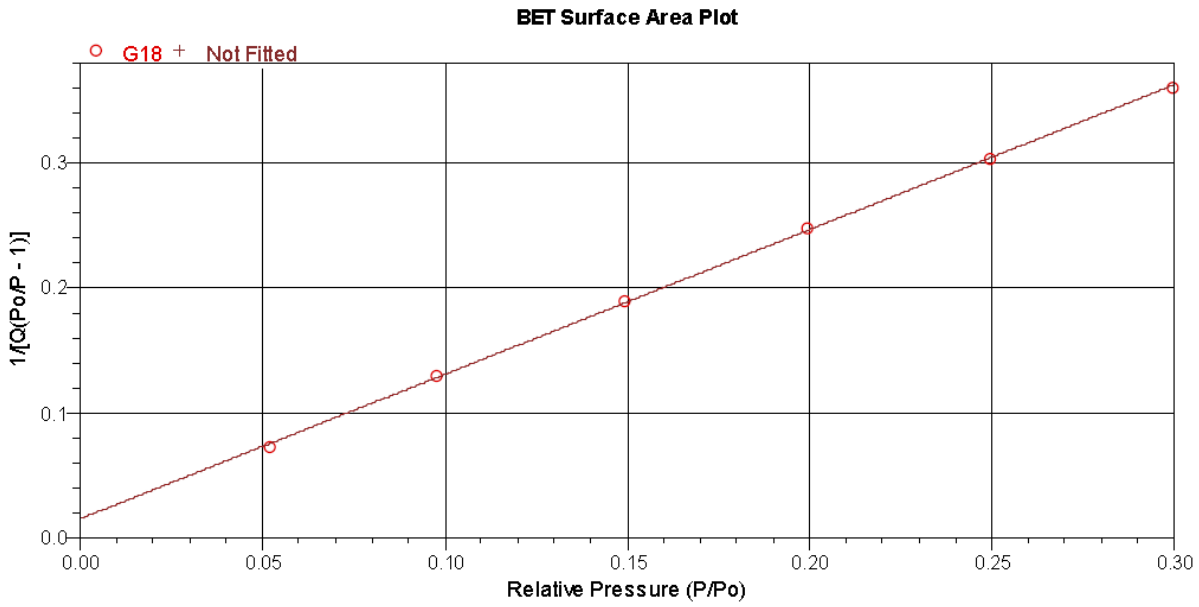
Started: 02.05.2018 16:51:59
Completed: 03.05.2018 07:23:47
Report Time: 03.05.2018 07:24:34
Sample Mass: 2,0066 g
Cold Free Space: 26,1457 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,1094 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.7092 ± 0.0286 m²/g
Slope: 1.158436 ± 0.008868 g/cm³ STP
Y-Intercept: 0.015009 ± 0.001721 g/cm³ STP
C: 78.181720
Qm: 0,8522 cm³/g STP
Correlation Coefficient: 0.9998828
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.052188747	0.7527	0.073151
0.097600300	0.8390	0.128912
0.149307691	0.9244	0.189861
0.199248267	1.0068	0.247144
0.249275659	1.0940	0.303529
0.299463484	1.1860	0.360437



Oville Formation

Sample: OV7
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\OV7.SMP

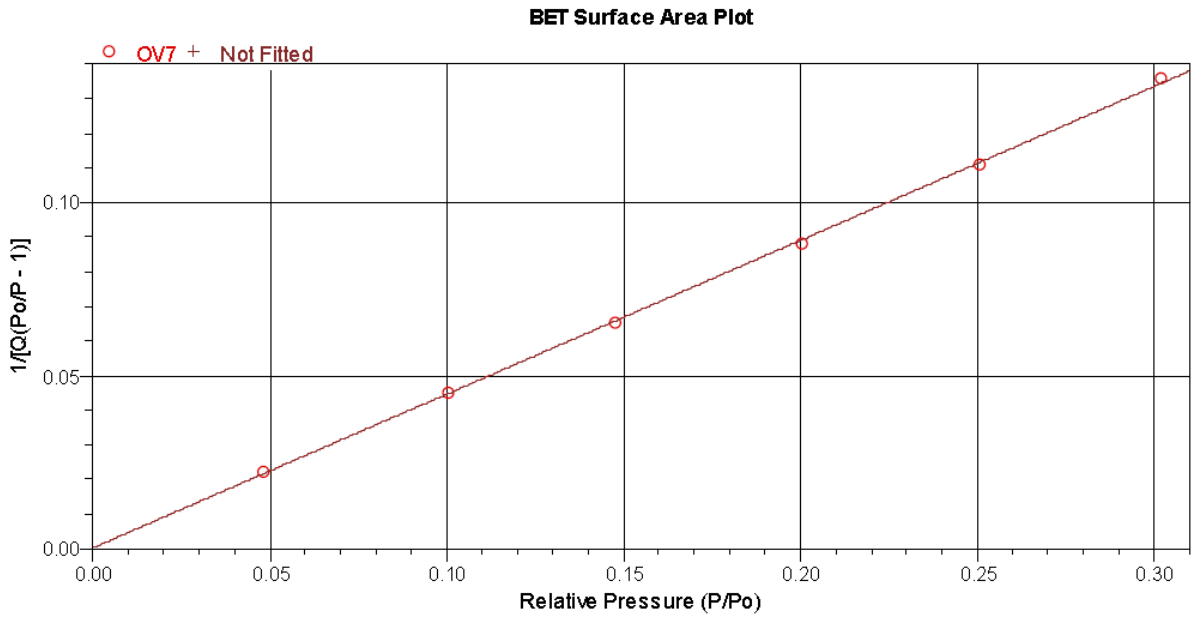
Started: 30.04.2018 16:47:06
Completed: 30.04.2018 18:50:13
Report Time: 30.04.2018 18:51:44
Sample Mass: 2,3517 g
Cold Free Space: 25,7529 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,9203 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 9.7963 ± 0.1082 m²/g
Slope: 0.444006 ± 0.004815 g/cm³ STP
Y-Intercept: 0.000304 ± 0.000940 g/cm³ STP
C: 1461.537817
Qm: 2,2507 cm³/g STP
Correlation Coefficient: 0.9997649
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.047995178	2.2405	0.022501
0.100685321	2.4844	0.045064
0.147826912	2.6592	0.065234
0.200321063	2.8386	0.088249
0.250805288	3.0117	0.111154
0.301920498	3.1888	0.135630



Barrios Formation

Sample: B4
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\B4.SMP

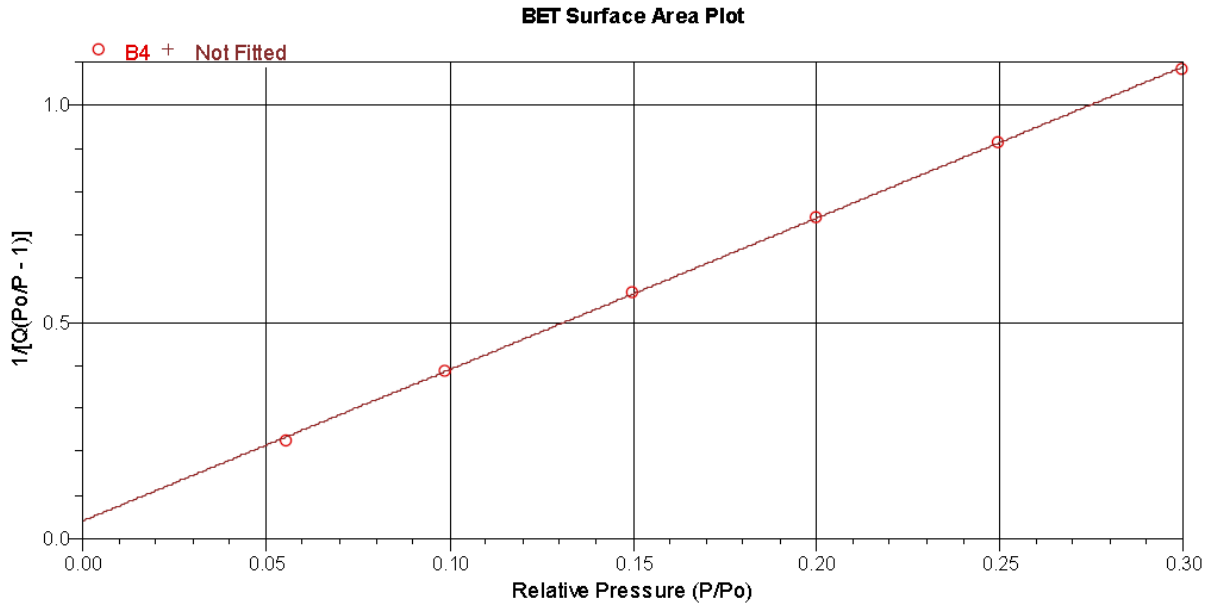
Started: 02.05.2018 14:38:57
Completed: 02.05.2018 16:28:53
Report Time: 02.05.2018 16:29:37
Sample Mass: 3,4853 g
Cold Free Space: 25,0612 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,7681 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.2314 ± 0.0085 m²/g
Slope: 3.494228 ± 0.023836 g/cm³ STP
Y-Intercept: 0.040465 ± 0.004638 g/cm³ STP
C: 87.351998
Qm: 0,2829 cm³/g STP
Correlation Coefficient: 0.9999069
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055300946	0.2568	0.227952
0.098708553	0.2831	0.386798
0.149627222	0.3099	0.567853
0.199642056	0.3361	0.742070
0.249659609	0.3642	0.913514
0.299612845	0.3952	1.082458



Sample: BT
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\BT.SMP

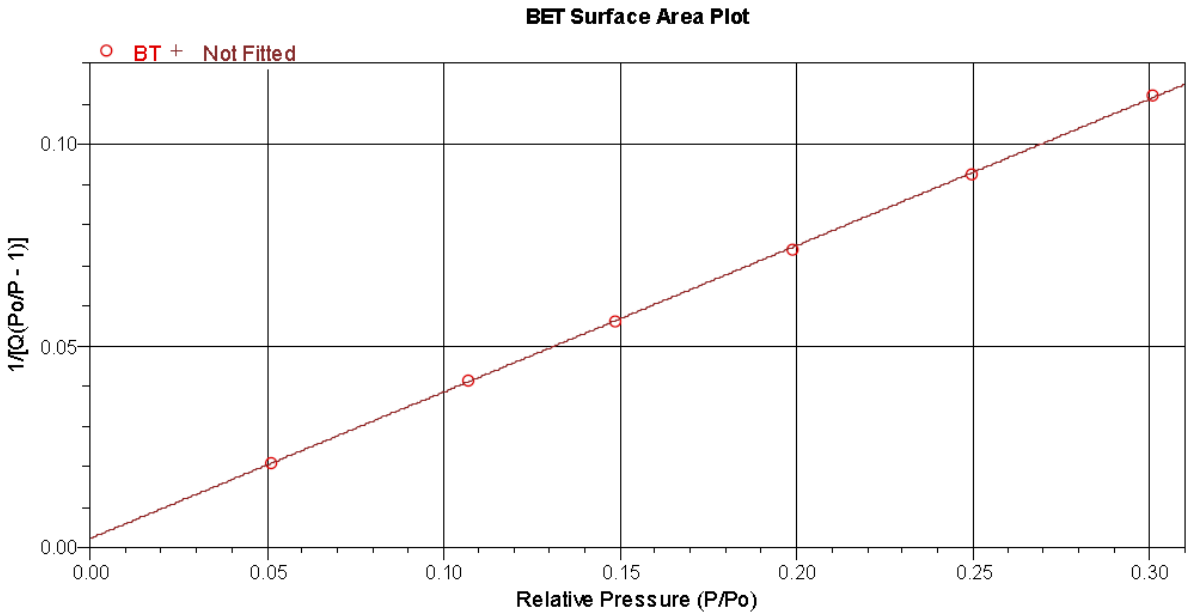
Started: 01.05.2018 15:23:07
Completed: 01.05.2018 18:17:21
Report Time: 01.05.2018 18:17:39
Sample Mass: 2,9705 g
Cold Free Space: 25,3118 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,8154 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 11.9177 ± 0.0574 m²/g
Slope: 0.363013 ± 0.001728 g/cm³ STP
Y-Intercept: 0.002207 ± 0.000337 g/cm³ STP
C: 165.493712
Qm: 2,7381 cm³/g STP
Correlation Coefficient: 0.9999547
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.051307156	2.5761	0.020994
0.107224908	2.9090	0.041287
0.148580064	3.1146	0.056030
0.198751772	3.3528	0.073984
0.249558109	3.5950	0.092502
0.300782752	3.8456	0.111861



San Pedro Formation

Sample: SP7
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\SP7.SMP

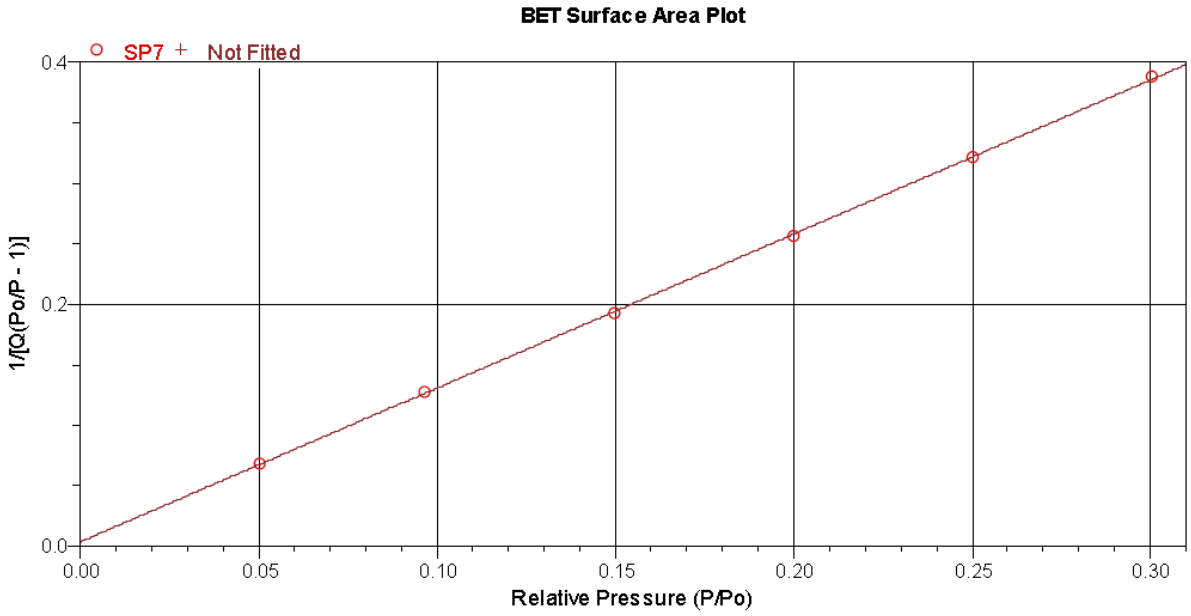
Started: 01.05.2018 18:34:11
Completed: 01.05.2018 20:43:58
Report Time: 01.05.2018 20:44:36
Sample Mass: 4,1611 g
Cold Free Space: 23,4990 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,3631 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.4121 ± 0.0167 m²/g
Slope: 1.272187 ± 0.006111 g/cm³ STP
Y-Intercept: 0.003458 ± 0.001190 g/cm³ STP
C: 368.883183
Qm: 0,7839 cm³/g STP
Correlation Coefficient: 0.9999539
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.050369517	0.7736	0.068565
0.096702951	0.8448	0.126721
0.149733448	0.9124	0.192999
0.200051325	0.9745	0.256633
0.250286099	1.0391	0.321290
0.300652168	1.1093	0.387532



La Vid Group Formation

Sample: LV3
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\LV3.SMP

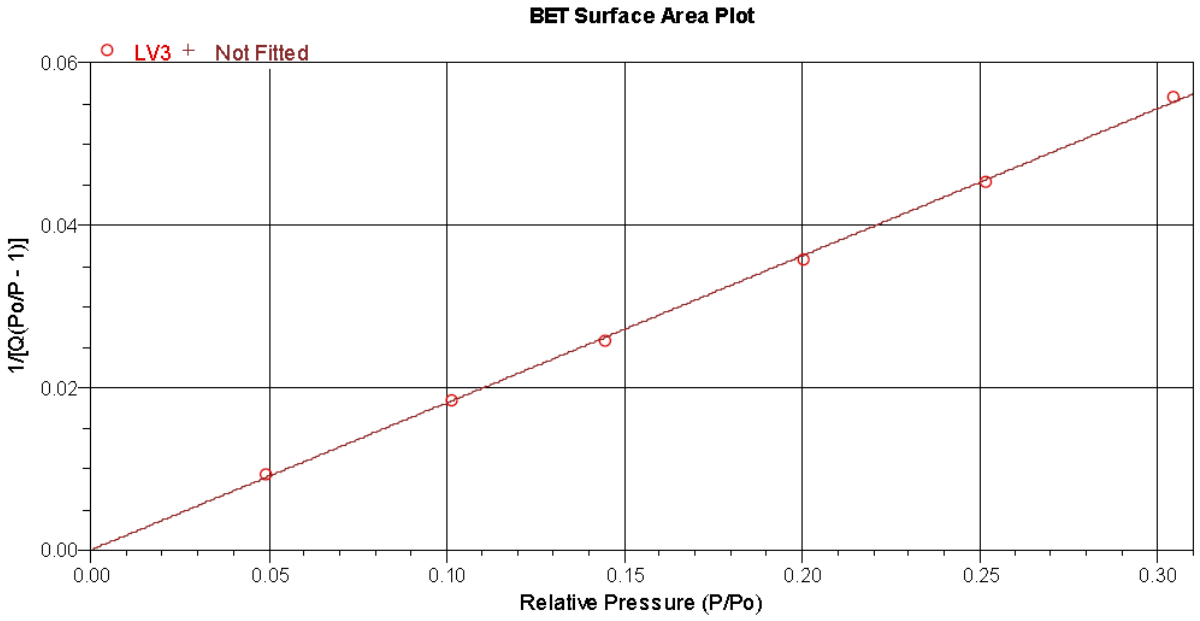
Started: 01.05.2018 18:34:11
Completed: 01.05.2018 20:43:58
Report Time: 01.05.2018 20:44:14
Sample Mass: 2,5558 g
Cold Free Space: 26,4702 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,1196 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 24.0314 ± 0.3385 m²/g
Slope: 0.181112 ± 0.002504 g/cm³ STP
Y-Intercept: 0.000009 ± 0.000490 g/cm³ STP
C: 20575.561525
Qm: 5,5212 cm³/g STP
Correlation Coefficient: 0.9996180
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.049094609	5.5177	0.009357
0.101429397	6.1289	0.018418
0.144515615	6.5345	0.025852
0.200302134	7.0060	0.035751
0.251779601	7.4267	0.045310
0.304649435	7.8442	0.055853



Sample: CollaD
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\CollaD.SMP

Started: 07.05.2018 15:51:12
Completed: 07.05.2018 17:30:30
Report Time: 07.05.2018 17:31:22
Sample Mass: 3,8123 g
Cold Free Space: 24,5659 cm³
Low Pressure Dose: None
Automatic Degas: No

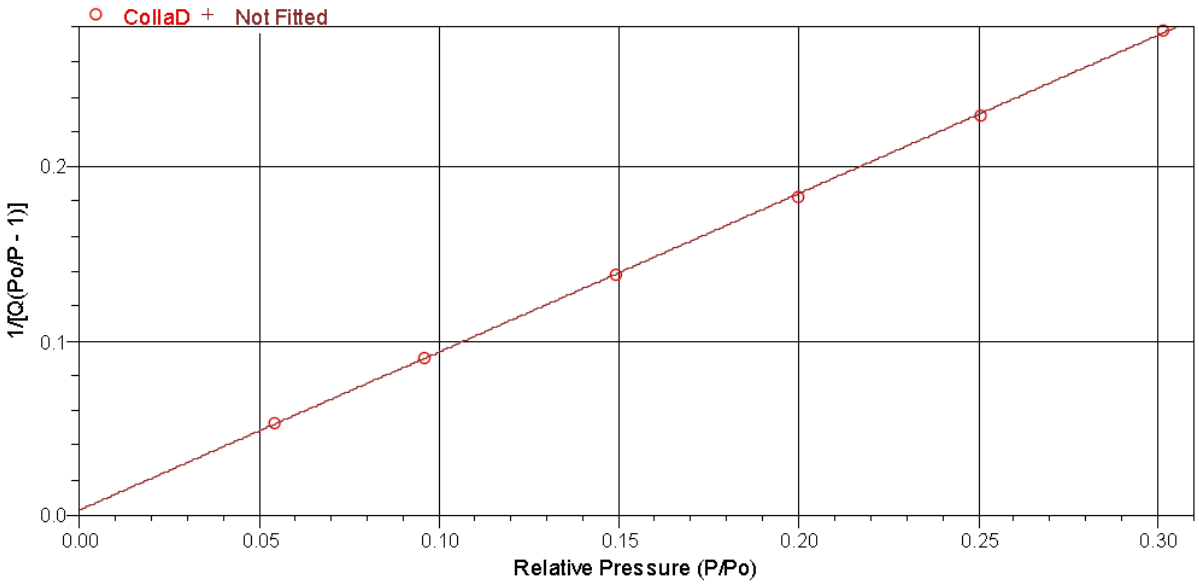
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,6154 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 4.7818 ± 0.0381 m²/g
Slope: 0.907237 ± 0.007117 g/cm³ STP
Y-Intercept: 0.003006 ± 0.001387 g/cm³ STP
C: 302.760932
Qm: 1,0986 cm³/g STP
Correlation Coefficient: 0.9998770
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054114532	1.0769	0.053126
0.095968755	1.1733	0.090480
0.149411204	1.2760	0.137665
0.199919689	1.3664	0.182877
0.250468423	1.4574	0.229285
0.301444797	1.5500	0.278409

BET Surface Area Plot



Santa Lucía Formation

Sample: SLL
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\SLL.SMP

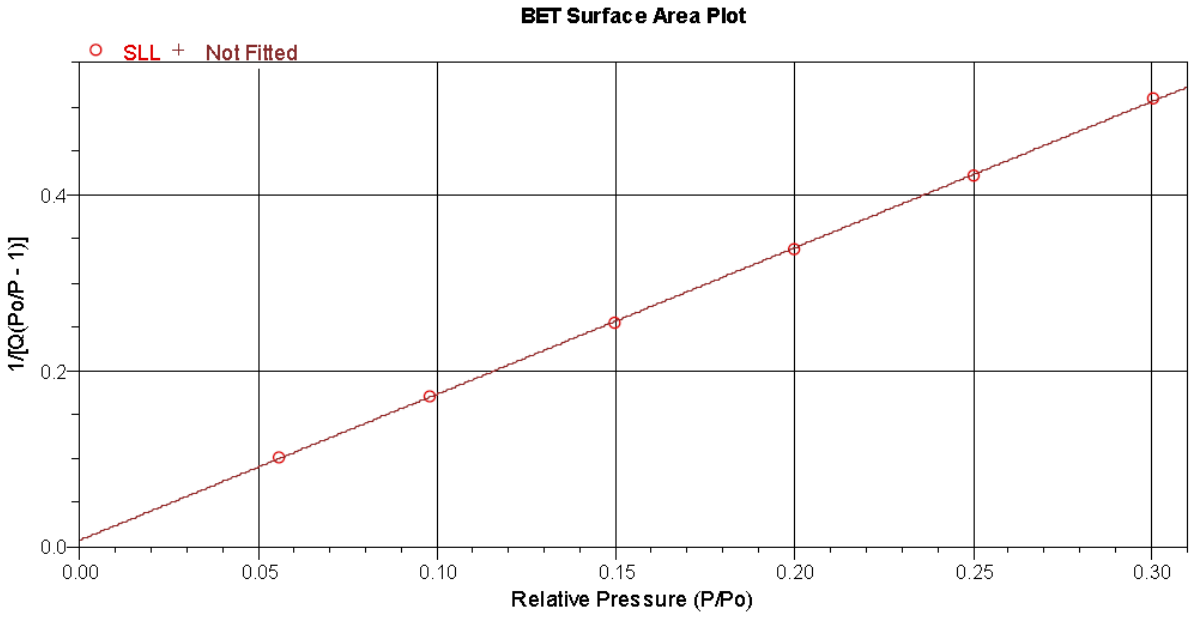
Started: 07.05.2018 17:44:57
Completed: 07.05.2018 19:22:57
Report Time: 07.05.2018 19:28:03
Sample Mass: 3,5718 g
Cold Free Space: 24,5726 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,7511 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.6110 ± 0.0136 m²/g
Slope: 1.659335 ± 0.008523 g/cm³ STP
Y-Intercept: 0.007695 ± 0.001661 g/cm³ STP
C: 216.646563
Qm: 0,5999 cm³/g STP
Correlation Coefficient: 0.9999472
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055540805	0.5826	0.100932
0.097825946	0.6355	0.170630
0.149723948	0.6901	0.255177
0.199969415	0.7401	0.337720
0.250085775	0.7913	0.421437
0.300598728	0.8447	0.508787



Huergas Formation

Sample: HU7
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\HU7.SMP

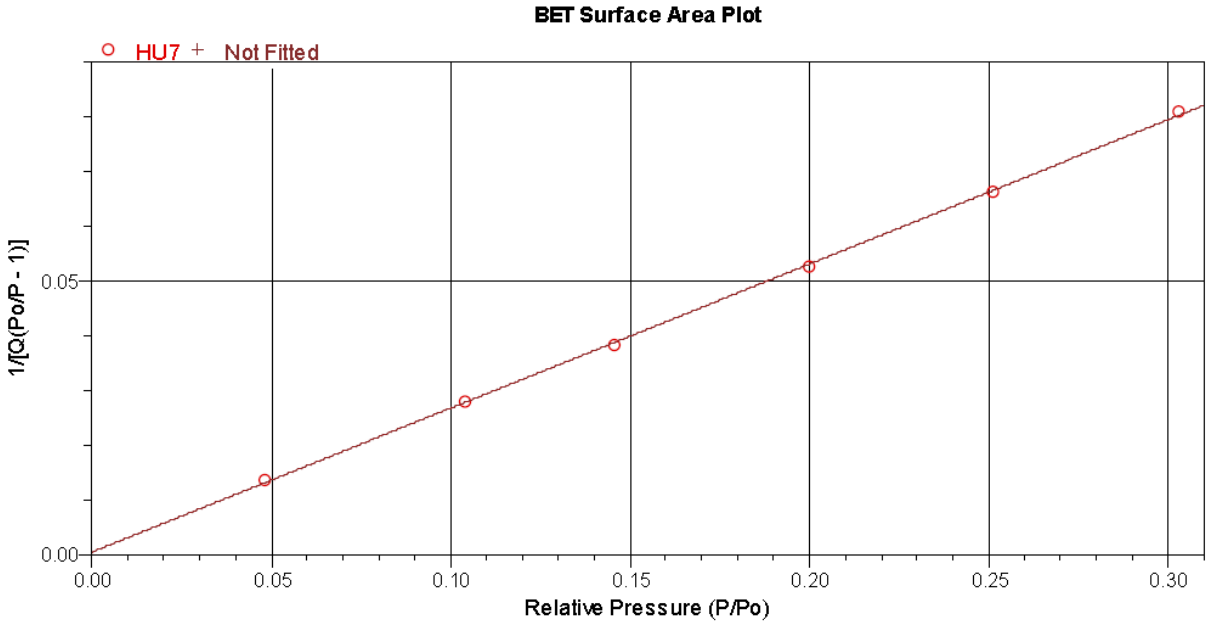
Started: 01.05.2018 15:23:07
Completed: 01.05.2018 18:17:20
Report Time: 01.05.2018 18:17:50
Sample Mass: 2,9546 g
Cold Free Space: 26,0617 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,9811 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 16.4913 ± 0.1813 m²/g
Slope: 0.263484 ± 0.002848 g/cm³ STP
Y-Intercept: 0.000447 ± 0.000556 g/cm³ STP
C: 590.758964
Qm: 3,7889 cm³/g STP
Correlation Coefficient: 0.9997665
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.048277958	3.7126	0.013663
0.104257296	4.1616	0.027968
0.145486654	4.4309	0.038425
0.199903954	4.7577	0.052515
0.250999382	5.0600	0.066227
0.302989494	5.3637	0.081045



Portilla Formation

Sample: Portilla
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\Portilla.SMP

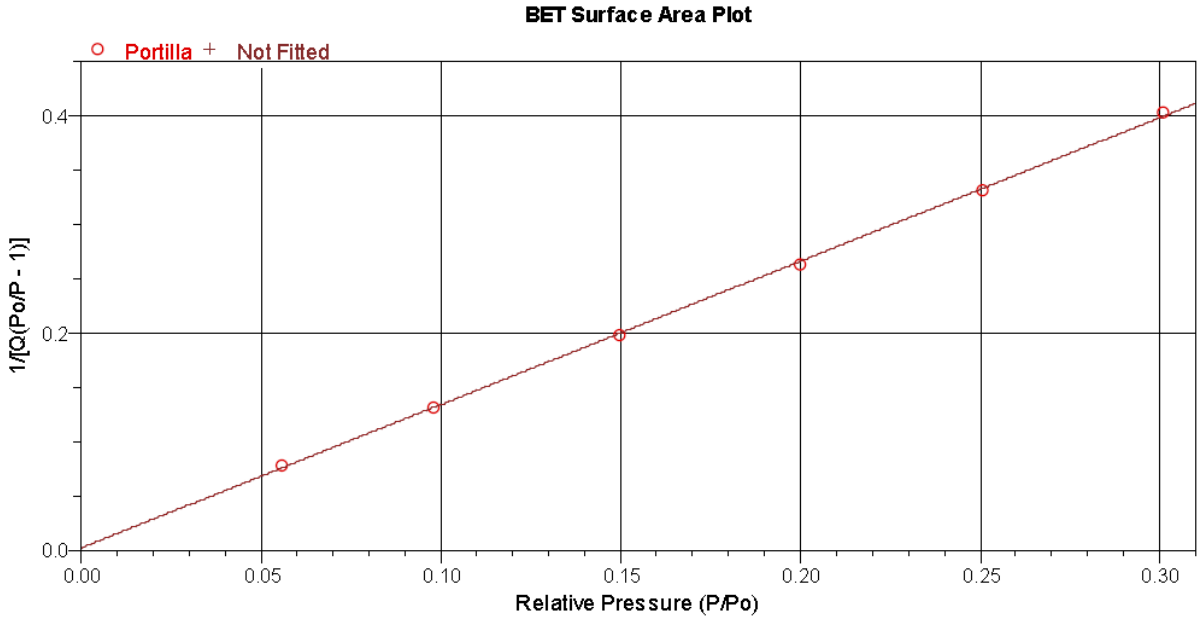
Started: 01.05.2018 18:34:11
Completed: 01.05.2018 20:43:59
Report Time: 01.05.2018 20:44:25
Sample Mass: 3,0474 g
Cold Free Space: 26,2682 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,0642 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.2907 ± 0.0300 m²/g
Slope: 1.320303 ± 0.011845 g/cm³ STP
Y-Intercept: 0.002372 ± 0.002312 g/cm³ STP
C: 557.583822
Qm: 0,7560 cm³/g STP
Correlation Coefficient: 0.9998391
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055643511	0.7565	0.077890
0.097741974	0.8221	0.131772
0.149813097	0.8880	0.198428
0.200168792	0.9474	0.264168
0.250538469	1.0070	0.331960
0.300924450	1.0689	0.402711



San Emiliano Formation

Sample: SE6
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\SE6.SMP

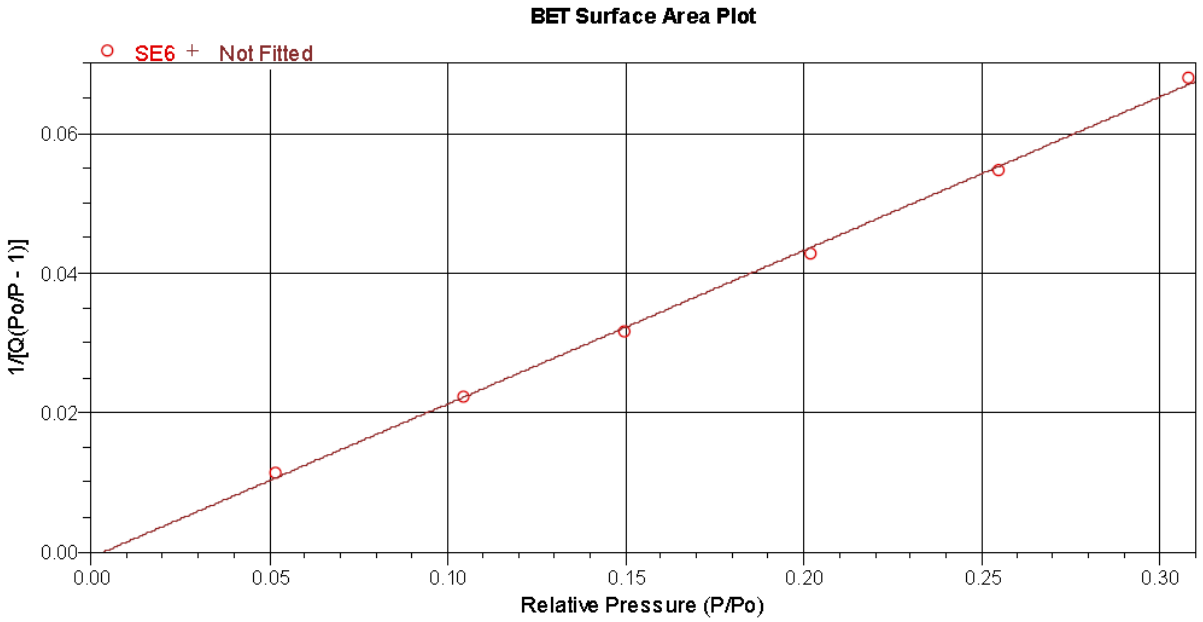
Started: 01.05.2018 15:23:07
Completed: 01.05.2018 18:17:21
Report Time: 01.05.2018 18:18:00
Sample Mass: 2,6117 g
Cold Free Space: 26,6374 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,1119 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 19.8770 ± 0.3970 m²/g
Slope: 0.219702 ± 0.004290 g/cm³ STP
Y-Intercept: -0.000727 ± 0.000852 g/cm³ STP
C: -301.338838
Qm: 4,5667 cm³/g STP
Correlation Coefficient: 0.9992383
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.051602003	4.7436	0.011470
0.104458896	5.2517	0.022211
0.149865153	5.5854	0.031562
0.202132818	5.9201	0.042794
0.254647257	6.2357	0.054789
0.308008581	6.5406	0.068053



Gijón Formation

Sample: Gijon
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\Gijon.SMP

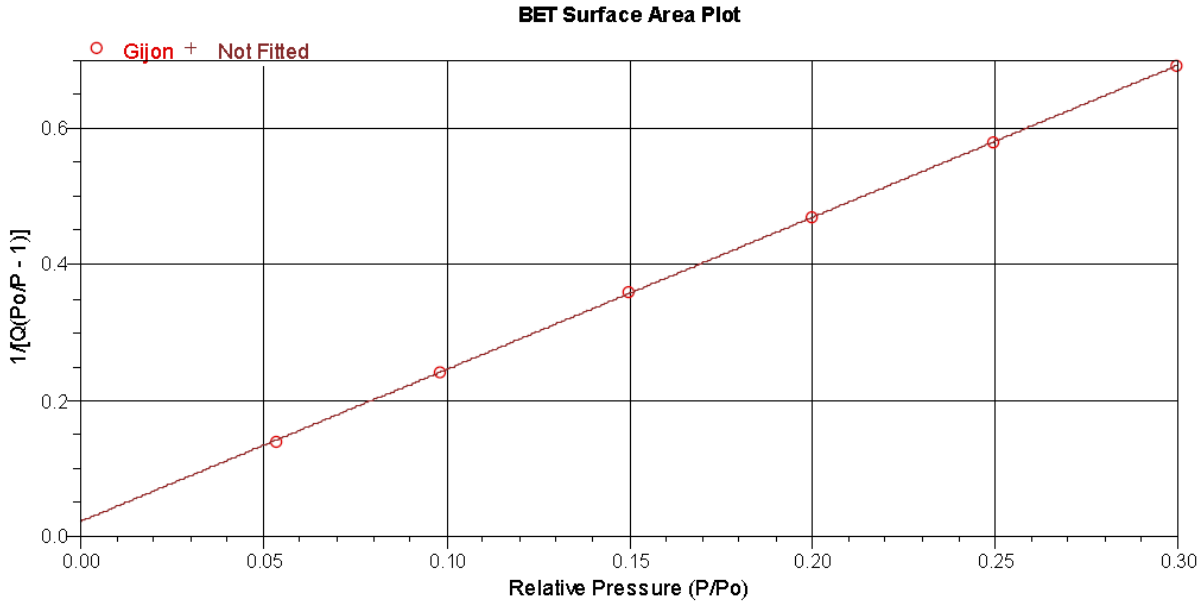
Started: 02.05.2018 16:51:59
Completed: 03.05.2018 07:23:46
Report Time: 03.05.2018 07:24:46
Sample Mass: 3,0870 g
Cold Free Space: 25,5325 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,9602 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.9259 ± 0.0067 m²/g
Slope: 2.238341 ± 0.007737 g/cm³ STP
Y-Intercept: 0.021666 ± 0.001504 g/cm³ STP
C: 104.310192
Qm: 0,4425 cm³/g STP
Correlation Coefficient: 0.9999761
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.053633304	0.4060	0.139594
0.098163902	0.4490	0.242437
0.149544406	0.4911	0.358070
0.199627460	0.5314	0.469367
0.249620914	0.5737	0.579868
0.299693332	0.6188	0.691553



Rodiles Formation

Sample: Rodiles
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\Rodiles.SMP

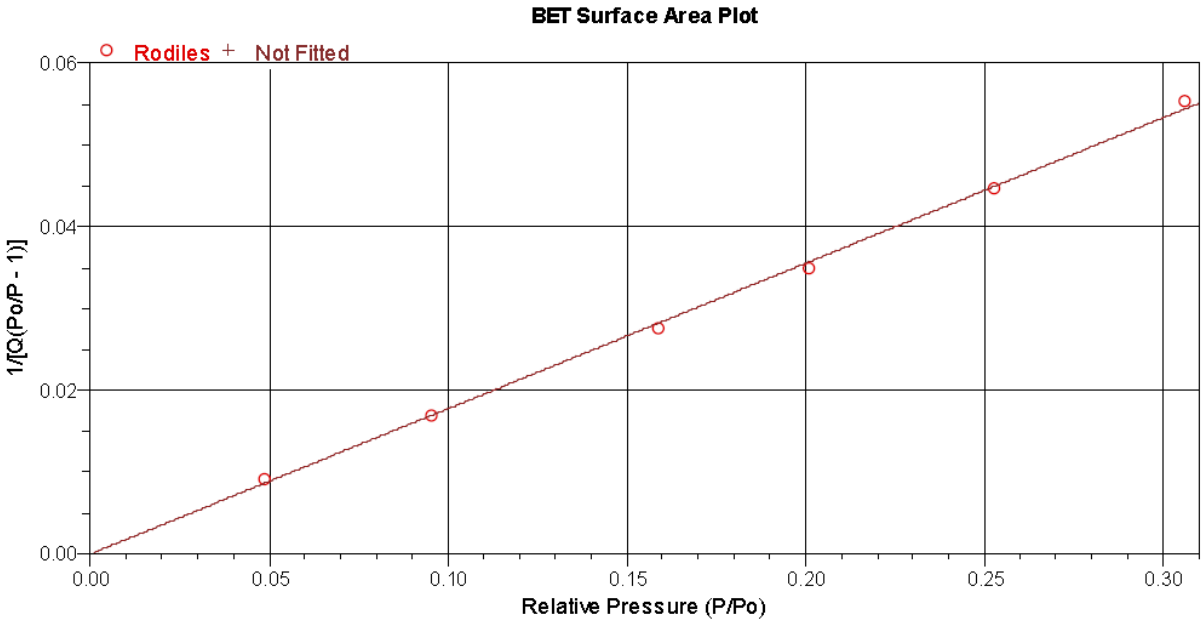
Started: 02.05.2018 16:51:59
Completed: 03.05.2018 07:23:47
Report Time: 03.05.2018 07:24:24
Sample Mass: 2,3972 g
Cold Free Space: 27,2875 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3000 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 24.4699 ± 0.4761 m²/g
Slope: 0.177948 ± 0.003395 g/cm³ STP
Y-Intercept: -0.000074 ± 0.000671 g/cm³ STP
C: -2416.258382
Qm: 5,6219 cm³/g STP
Correlation Coefficient: 0.9992728
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.048603196	5.5395	0.009222
0.095131818	6.2198	0.016903
0.158670192	6.8444	0.027554
0.200840930	7.1819	0.034993
0.252559224	7.5833	0.044558
0.305880530	7.9756	0.055253



Vega Formation

Sample: Vega
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\Vega.SMP

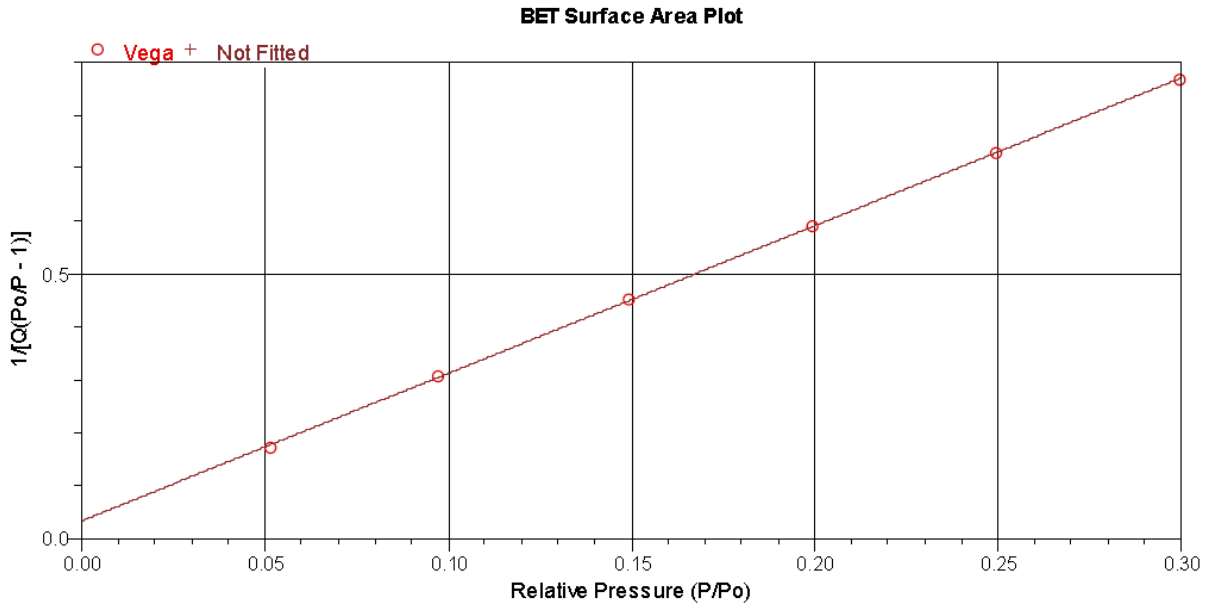
Started: 07.05.2018 15:51:12
Completed: 07.05.2018 17:30:30
Report Time: 07.05.2018 17:31:48
Sample Mass: 4,5543 g
Cold Free Space: 24,2888 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,5224 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.5429 ± 0.0072 m²/g
Slope: 2.787328 ± 0.012995 g/cm³ STP
Y-Intercept: 0.033676 ± 0.002524 g/cm³ STP
C: 83.768038
Qm: 0,3545 cm³/g STP
Correlation Coefficient: 0.9999565
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.051424484	0.3127	0.173384
0.097344609	0.3513	0.306986
0.149351517	0.3878	0.452768
0.199467648	0.4217	0.590892
0.249511474	0.4565	0.728272
0.299689779	0.4933	0.867502



Sample: VC
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Spain\Vega Cong.SMP

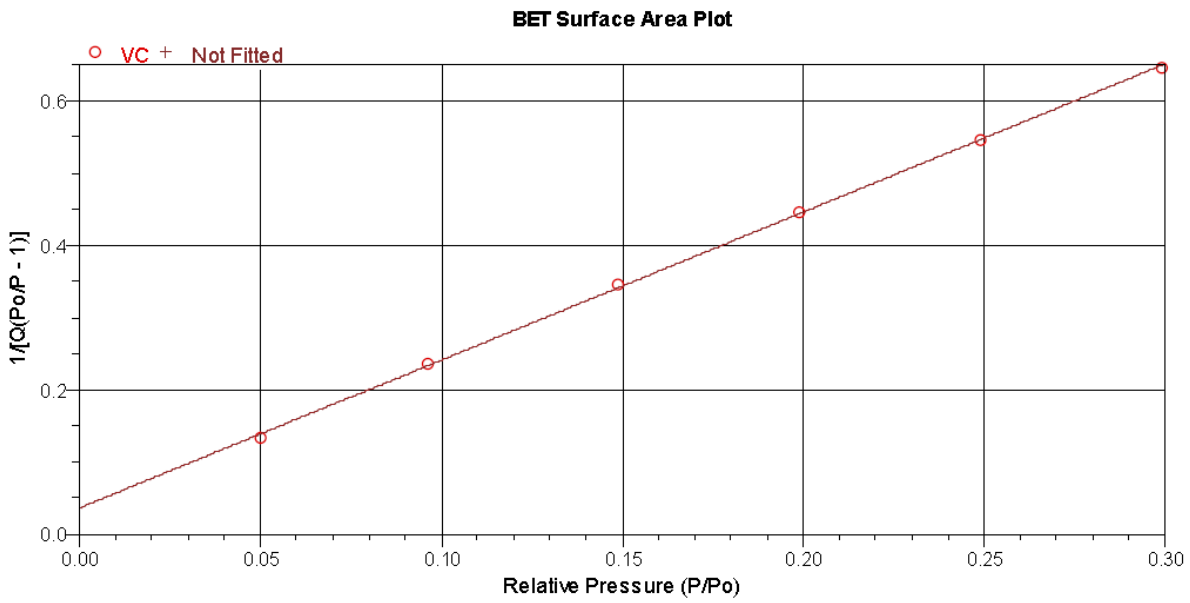
Started: 30.04.2018 16:47:06
Completed: 30.04.2018 18:50:13
Report Time: 30.04.2018 18:51:56
Sample Mass: 4,3912 g
Cold Free Space: 24,2986 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,5204 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.0897 ± 0.0224 m²/g
Slope: 2.046156 ± 0.021876 g/cm³ STP
Y-Intercept: 0.036696 ± 0.004234 g/cm³ STP
C: 56.759477
Qm: 0,4801 cm³/g STP
Correlation Coefficient: 0.9997715
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.050254490	0.3958	0.133703
0.096112601	0.4512	0.235678
0.148780282	0.5055	0.345746
0.198870298	0.5557	0.446671
0.248796896	0.6074	0.545310
0.299071409	0.6616	0.644930



G. BET Report for South American Samples

Sample: 335_Mix
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\South Am...\335_Mix.SMP

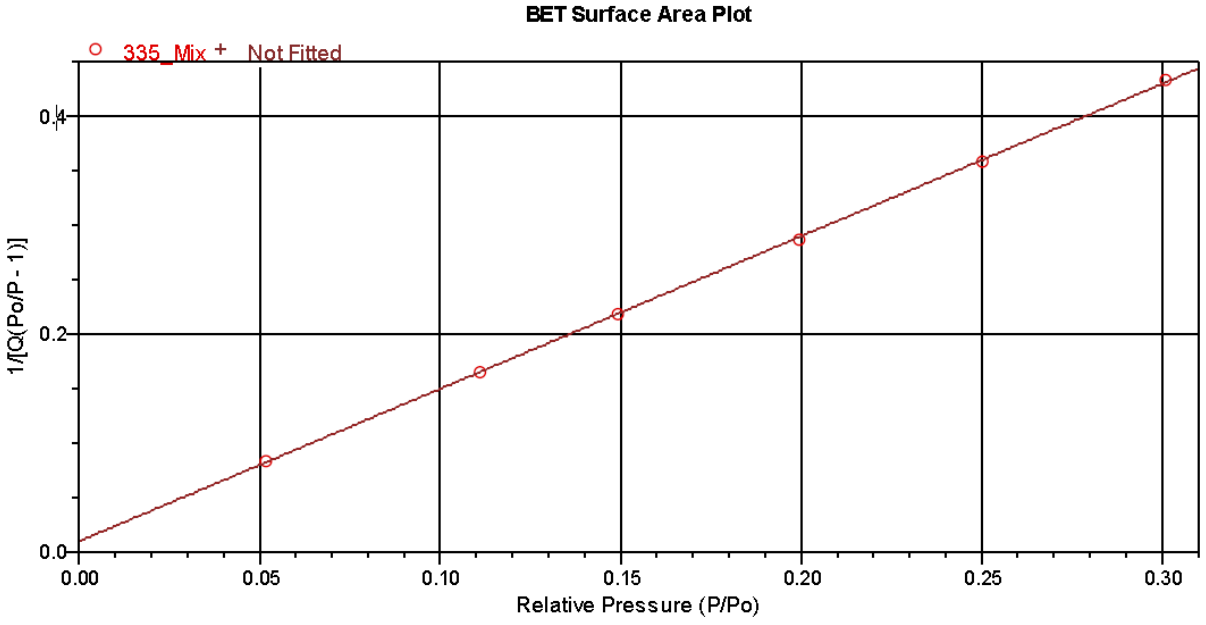
Started: 11.06.2018 14:14:12
Completed: 11.06.2018 16:07:10
Report Time: 11.06.2018 16:17:14
Sample Mass: 5,3645 g
Cold Free Space: 23,0708 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,2414 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.0870 ± 0.0207 m²/g
Slope: 1.400200 ± 0.009267 g/cm³ STP
Y-Intercept: 0.009774 ± 0.001815 g/cm³ STP
C: 144.262128
Qm: 0,7092 cm³/g STP
Correlation Coefficient: 0.9999124
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.051831279	0.6553	0.083425
0.110850800	0.7526	0.165654
0.149141443	0.8047	0.217820
0.199365862	0.8678	0.286929
0.250072372	0.9302	0.358481
0.300968551	0.9928	0.433669



Sample: SDA_Mix
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\South Am...\SDA_Mix.SMP

Started: 08.06.2018 14:22:02
Completed: 08.06.2018 16:04:39
Report Time: 08.06.2018 16:06:25
Sample Mass: 3,0171 g
Cold Free Space: 24,3574 cm³
Low Pressure Dose: None
Automatic Degas: No

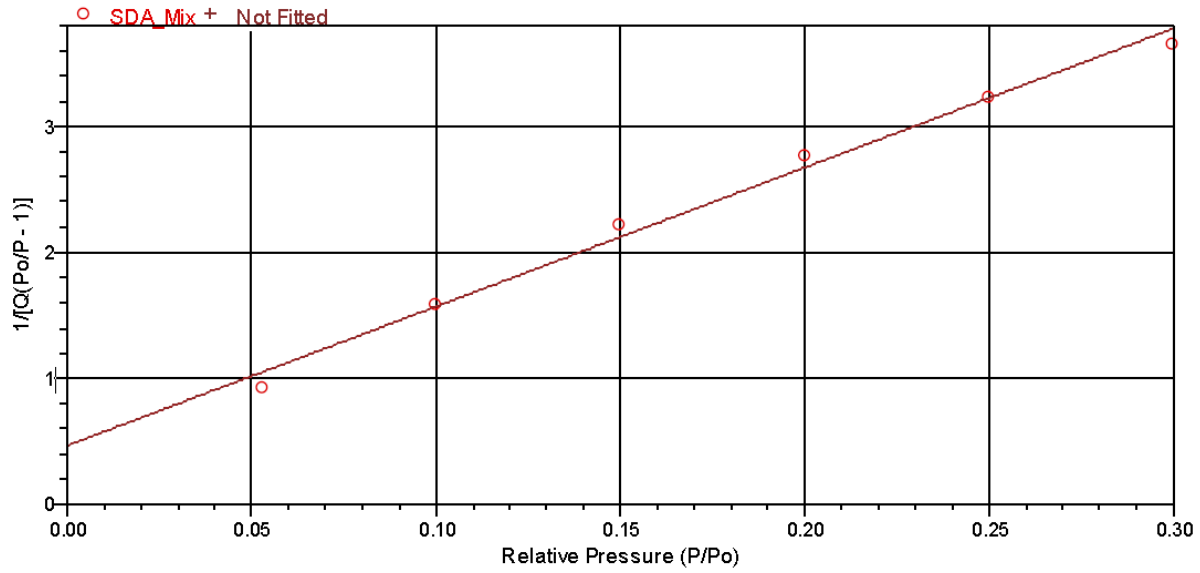
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,5623 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.3781 ± 0.0177 m²/g
Slope: 11.046968 ± 0.528168 g/cm³ STP
Y-Intercept: 0.465076 ± 0.102715 g/cm³ STP
C: 24.753018
Qm: 0,0869 cm³/g STP
Correlation Coefficient: 0.9954593
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.052641437	0.0602	0.922852
0.099447427	0.0694	1.590635
0.149732261	0.0794	2.218909
0.199690002	0.0902	2.765878
0.249567272	0.1027	3.237148
0.299467570	0.1168	3.660383

BET Surface Area Plot



Sample: Tul Tul_Mix
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\Sout...\Tul Tul_Mix.SMP

Started: 08.06.2018 14:22:02
Completed: 08.06.2018 16:04:39
Report Time: 08.06.2018 16:06:34
Sample Mass: 3,2434 g
Cold Free Space: 25,5427 cm³
Low Pressure Dose: None
Automatic Degas: No

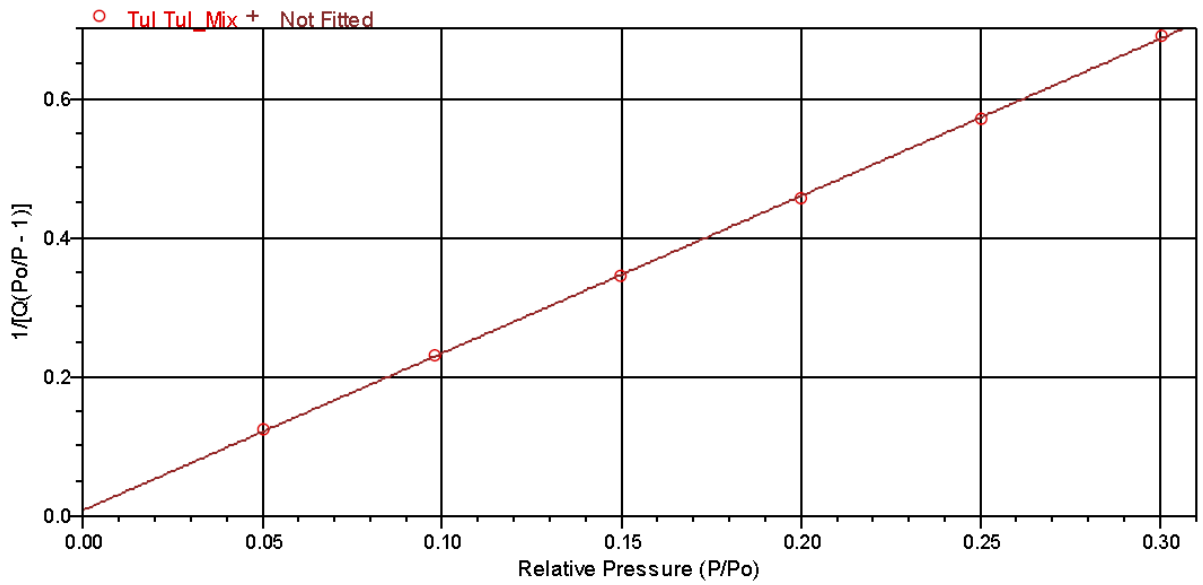
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,8519 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.9224 ± 0.0133 m²/g
Slope: 2.256057 ± 0.015384 g/cm³ STP
Y-Intercept: 0.008133 ± 0.002995 g/cm³ STP
C: 278.400117
Qm: 0,4417 cm³/g STP
Correlation Coefficient: 0.9999070
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.050143633	0.4271	0.123606
0.098114375	0.4725	0.230262
0.149707494	0.5122	0.343770
0.200059186	0.5483	0.456106
0.250189853	0.5845	0.570833
0.300460921	0.6224	0.690093

BET Surface Area Plot



Sample: PAY_Mix
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\South Am...\PAY_Mix.SMP

Started: 08.06.2018 16:13:04
Completed: 08.06.2018 17:42:25
Report Time: 08.06.2018 17:45:37
Sample Mass: 2,9282 g
Cold Free Space: 25,0975 cm³
Low Pressure Dose: None
Automatic Degas: No

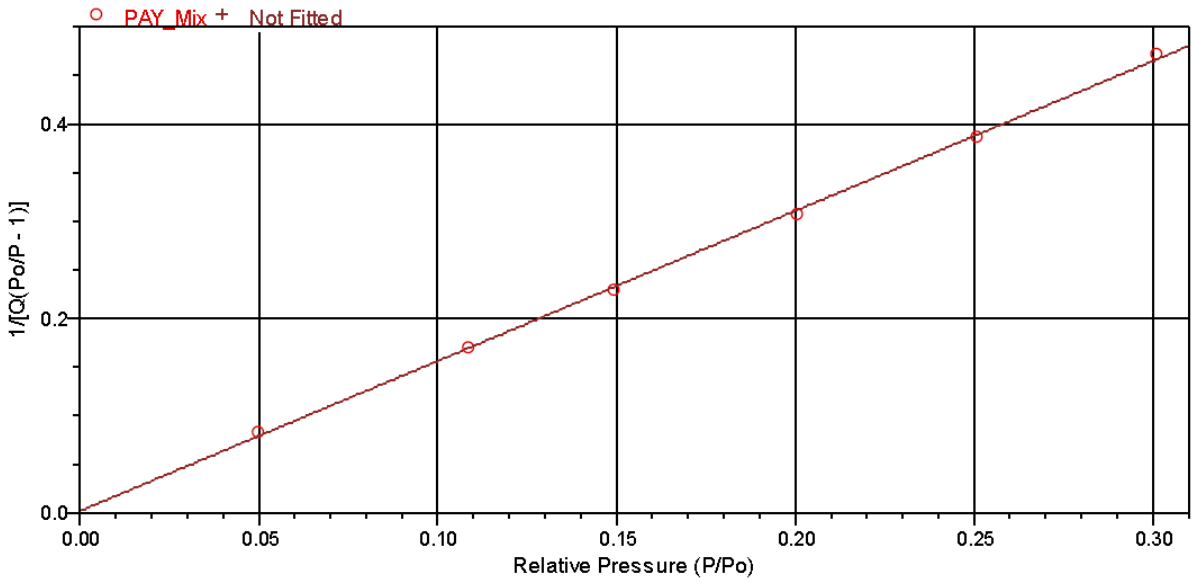
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,8346 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.8176 ± 0.0370 m²/g
Slope: 1.542728 ± 0.019893 g/cm³ STP
Y-Intercept: 0.002037 ± 0.003895 g/cm³ STP
C: 758.190220
Qm: 0,6473 cm³/g STP
Correlation Coefficient: 0.9996676
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.049672525	0.6334	0.082520
0.108729537	0.7195	0.169564
0.149311655	0.7646	0.229564
0.200325581	0.8159	0.307030
0.250548967	0.8644	0.386759
0.300943888	0.9133	0.471357

BET Surface Area Plot



Sample: I62_Mix
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\South Am...\I62_Mix.SMP

Started: 08.06.2018 16:13:04
Completed: 08.06.2018 17:42:24
Report Time: 08.06.2018 17:45:14
Sample Mass: 3,0603 g
Cold Free Space: 25,0965 cm³
Low Pressure Dose: None
Automatic Degas: No

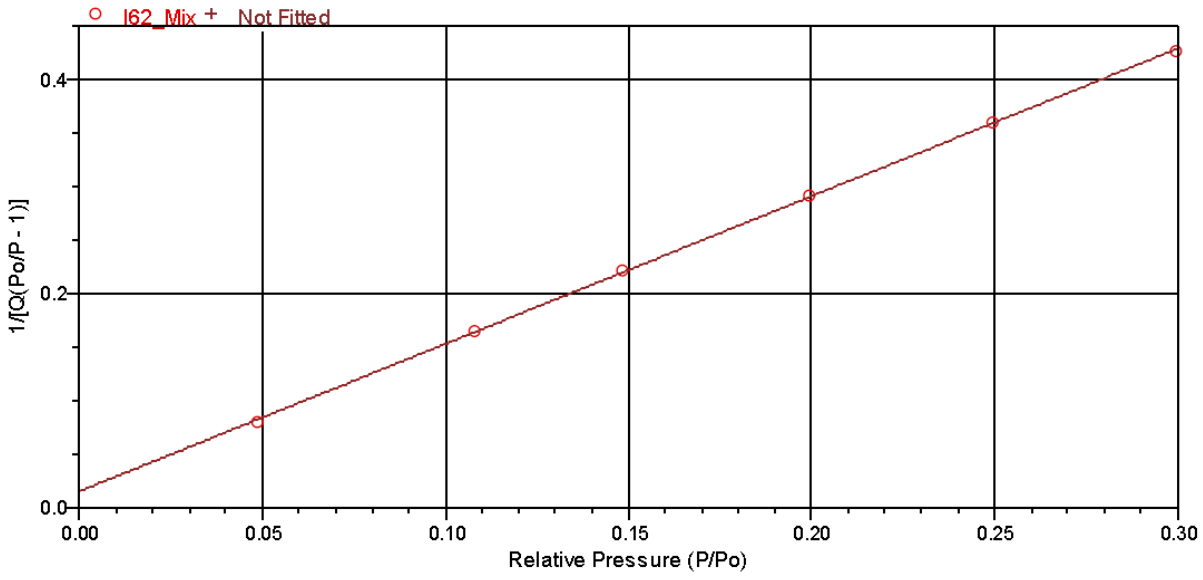
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,7453 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.1212 ± 0.0198 m²/g
Slope: 1.379289 ± 0.008672 g/cm³ STP
Y-Intercept: 0.015211 ± 0.001690 g/cm³ STP
C: 91.677649
Qm: 0,7171 cm³/g STP
Correlation Coefficient: 0.9999210
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.048393917	0.6385	0.079653
0.107858387	0.7320	0.165169
0.148443690	0.7867	0.221590
0.199545836	0.8551	0.291539
0.249584890	0.9255	0.359361
0.299530752	1.0018	0.426838

BET Surface Area Plot



Sample: LN_Mix
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\South Ame...\LN_Mix.SMP

Started: 08.06.2018 16:13:04
Completed: 08.06.2018 17:42:25
Report Time: 08.06.2018 17:45:24
Sample Mass: 2,8264 g
Cold Free Space: 26,3217 cm³
Low Pressure Dose: None
Automatic Degas: No

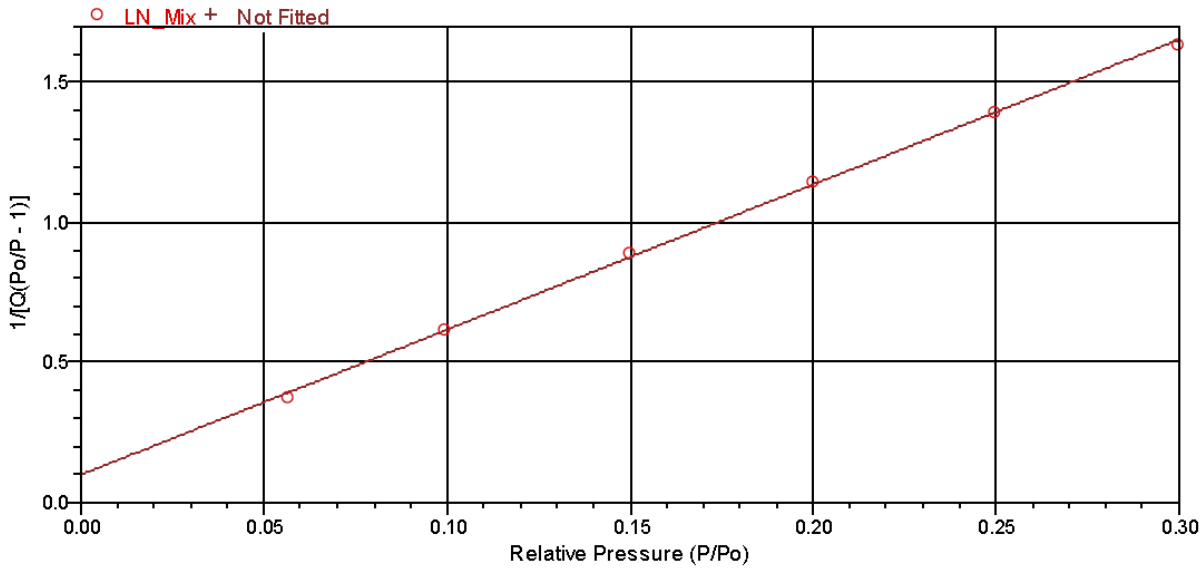
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,0640 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.8236 ± 0.0117 m²/g
Slope: 5.186377 ± 0.073830 g/cm³ STP
Y-Intercept: 0.098141 ± 0.014374 g/cm³ STP
C: 53.846351
Qm: 0,1892 cm³/g STP
Correlation Coefficient: 0.9995950
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.056386932	0.1601	0.373137
0.099200794	0.1787	0.616255
0.149685214	0.1981	0.888702
0.199652535	0.2176	1.146552
0.249654430	0.2386	1.394720
0.299679458	0.2614	1.637263

BET Surface Area Plot



Sample: Galan_Mix
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\South ...\Galan_Mix.SMP

Started: 08.06.2018 14:22:02
Completed: 08.06.2018 16:04:38
Report Time: 08.06.2018 16:06:15
Sample Mass: 3,2995 g
Cold Free Space: 25,2731 cm³
Low Pressure Dose: None
Automatic Degas: No

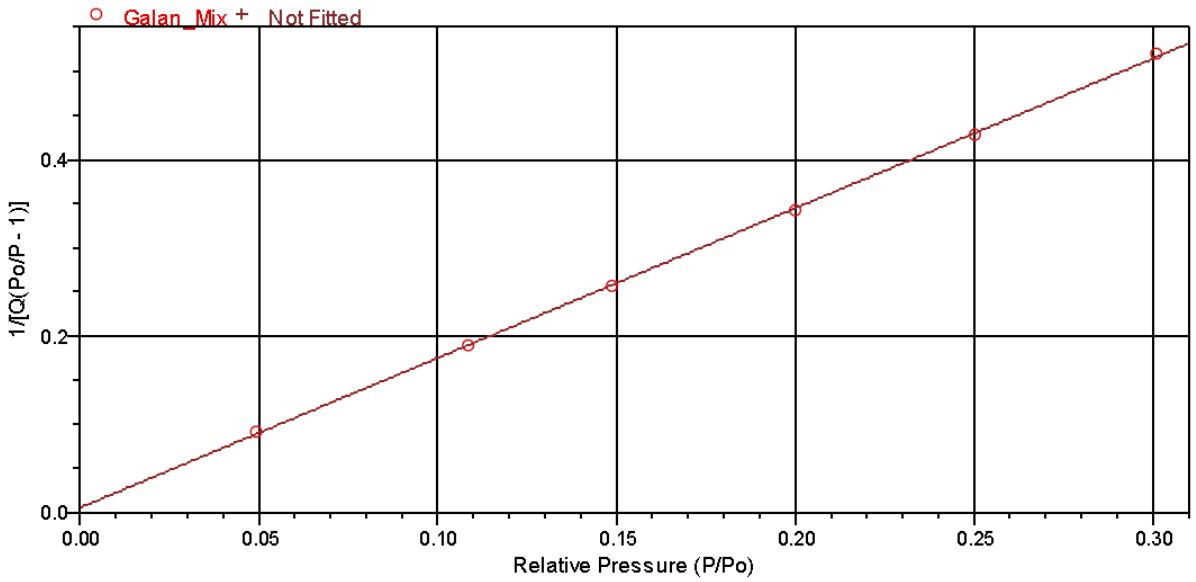
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,8031 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.5592 ± 0.0246 m²/g
Slope: 1.695219 ± 0.016016 g/cm³ STP
Y-Intercept: 0.005527 ± 0.003133 g/cm³ STP
C: 307.735850
Qm: 0,5880 cm³/g STP
Correlation Coefficient: 0.9998215
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.048987140	0.5638	0.091367
0.108707955	0.6418	0.190037
0.148934114	0.6839	0.255889
0.200104390	0.7328	0.341363
0.250340917	0.7799	0.428204
0.300753929	0.8279	0.519551

BET Surface Area Plot



H. Revised Sample Analysis

Accuracy

Sample: A5_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\A5_Pellet(2).SMP

Started: 02.02.2018 13:37:29
Completed: 02.02.2018 14:58:16
Report Time: 02.02.2018 14:58:35
Sample Mass: 2,0553 g
Cold Free Space: 27,2867 cm³
Low Pressure Dose: None
Automatic Degas: No

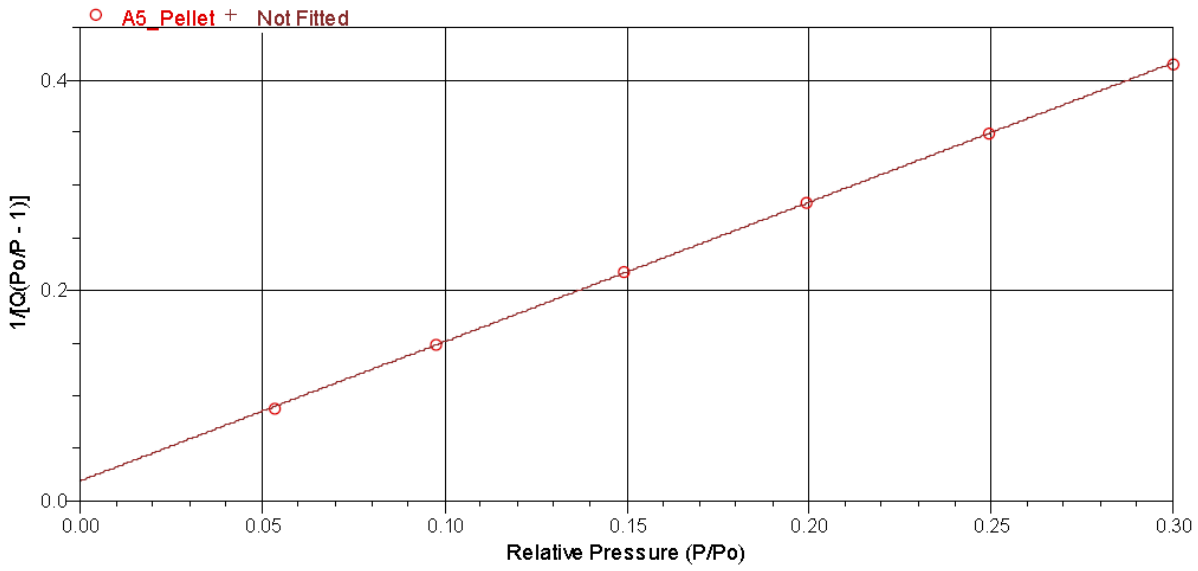
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3847 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 3.2403 ± 0.0153 m²/g
Slope: 1.324342 ± 0.006244 g/cm³ STP
Y-Intercept: 0.018906 ± 0.001214 g/cm³ STP
C: 71.047571
Qm: 0,7445 cm³/g STP
Correlation Coefficient: 0.9999555
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.053572731	0.6424	0.088109
0.097515979	0.7252	0.148995
0.149437079	0.8053	0.218158
0.199476717	0.8785	0.283643
0.249577231	0.9528	0.349041
0.299804507	1.0312	0.415236

BET Surface Area Plot



Sample: K1_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\K1_Pellet(2).SMP

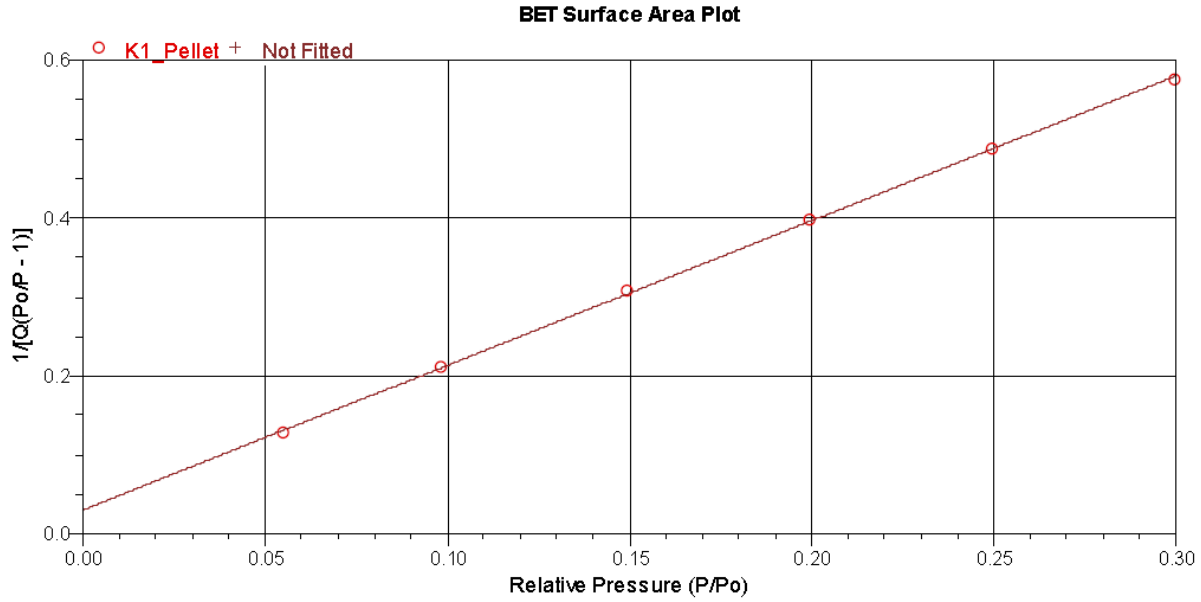
Started: 02.02.2018 15:09:47
Completed: 02.02.2018 16:28:39
Report Time: 02.02.2018 16:31:00
Sample Mass: 2,0934 g
Cold Free Space: 26,8229 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2523 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.3362 ± 0.0198 m²/g
Slope: 1.833204 ± 0.015501 g/cm³ STP
Y-Intercept: 0.029866 ± 0.003013 g/cm³ STP
C: 62.380884
Qm: 0,5367 cm³/g STP
Correlation Coefficient: 0.9998570
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055153385	0.4596	0.127010
0.098218840	0.5157	0.211199
0.149466695	0.5723	0.307077
0.199455828	0.6263	0.397821
0.249447986	0.6823	0.487133
0.299454925	0.7421	0.576017



Sample: MS4_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\MS4_Pellet(2).SMP

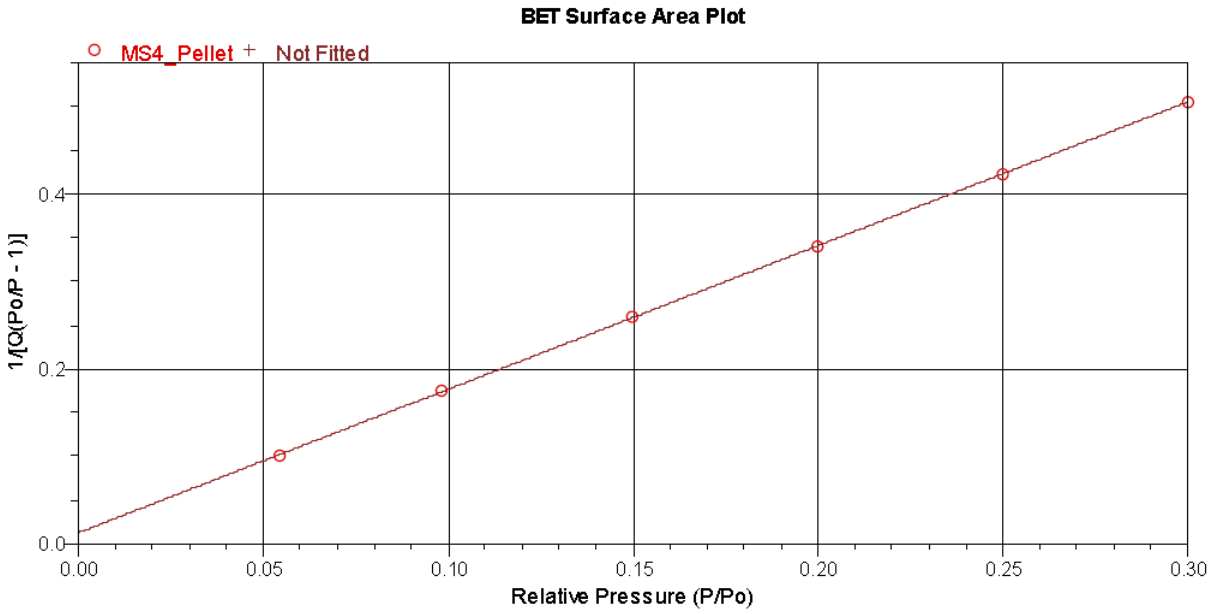
Started: 02.02.2018 15:09:47
Completed: 02.02.2018 16:28:39
Report Time: 02.02.2018 16:31:10
Sample Mass: 2,0748 g
Cold Free Space: 25,9806 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,9975 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.6309 ± 0.0044 m²/g
Slope: 1.641773 ± 0.002745 g/cm³ STP
Y-Intercept: 0.012661 ± 0.000534 g/cm³ STP
C: 130.673942
Qm: 0,6044 cm³/g STP
Correlation Coefficient: 0.9999944
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054435662	0.5665	0.101616
0.098431662	0.6243	0.174871
0.149672702	0.6805	0.258656
0.199765887	0.7335	0.340338
0.249782721	0.7887	0.422126
0.299999653	0.8476	0.505648



Approximate 1 gram Sample Mass

Sample: SK1_Pellet(2)
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\SK1_Pellet(2).SMP

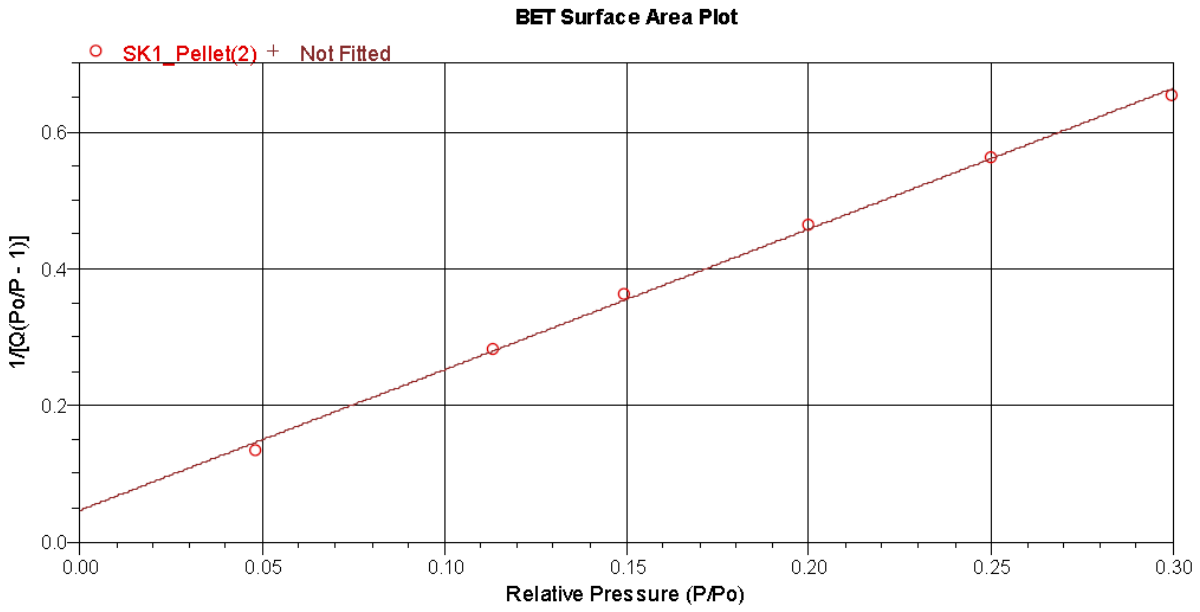
Started: 23.01.2018 15:33:34
Completed: 23.01.2018 16:51:58
Report Time: 23.01.2018 16:52:44
Sample Mass: 1,0528 g
Cold Free Space: 28,9863 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,8427 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.0713 ± 0.0472 m²/g
Slope: 2.054494 ± 0.047018 g/cm³ STP
Y-Intercept: 0.046920 ± 0.009197 g/cm³ STP
C: 44.787489
Qm: 0,4759 cm³/g STP
Correlation Coefficient: 0.9989542
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.048315641	0.3764	0.134887
0.113153279	0.4497	0.283703
0.149508868	0.4856	0.361996
0.199794147	0.5367	0.465173
0.249760929	0.5929	0.561465
0.299671544	0.6558	0.652476



Sample: SK2_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\SK2_Pellet.SMP

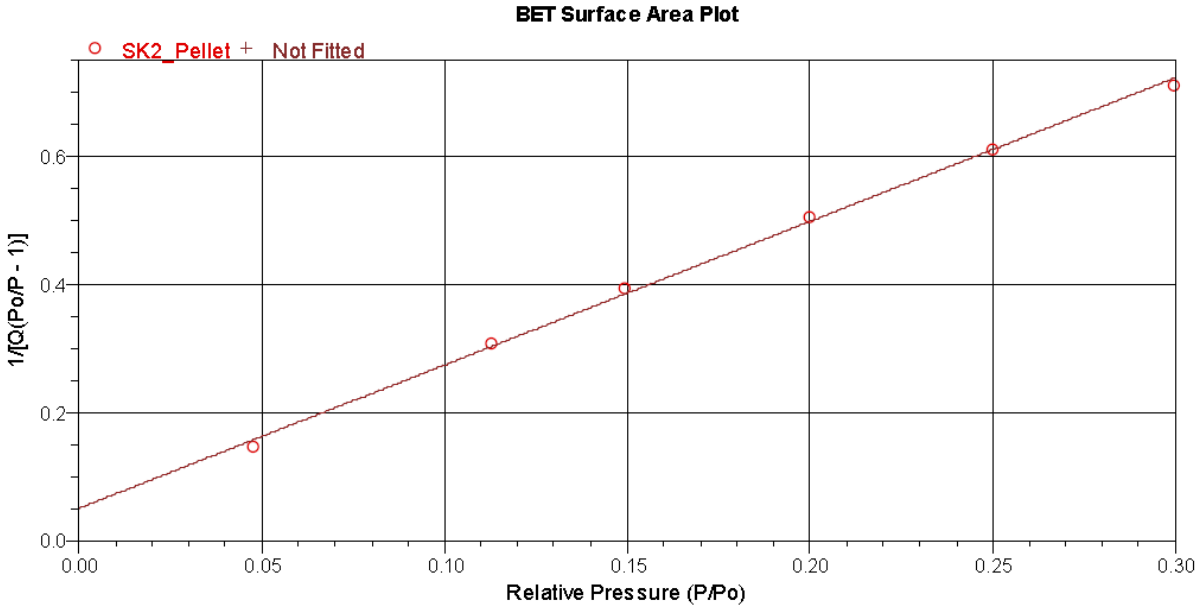
Started: 22.01.2018 16:20:59
Completed: 22.01.2018 17:39:51
Report Time: 22.01.2018 17:41:00
Sample Mass: 1,1807 g
Cold Free Space: 26,9778 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2912 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.8990 ± 0.0406 m²/g
Slope: 2.241293 ± 0.048060 g/cm³ STP
Y-Intercept: 0.050766 ± 0.009398 g/cm³ STP
C: 45.149466
Qm: 0,4363 cm³/g STP
Correlation Coefficient: 0.9990816
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.047705232	0.3432	0.145952
0.112942717	0.4125	0.308693
0.149458264	0.4461	0.393927
0.199767192	0.4930	0.506325
0.249682893	0.5443	0.611427
0.299668314	0.6007	0.712306



5 Hours of Degassing

Sample: SK3_Pellet5
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\SK3_Pellet5.SMP

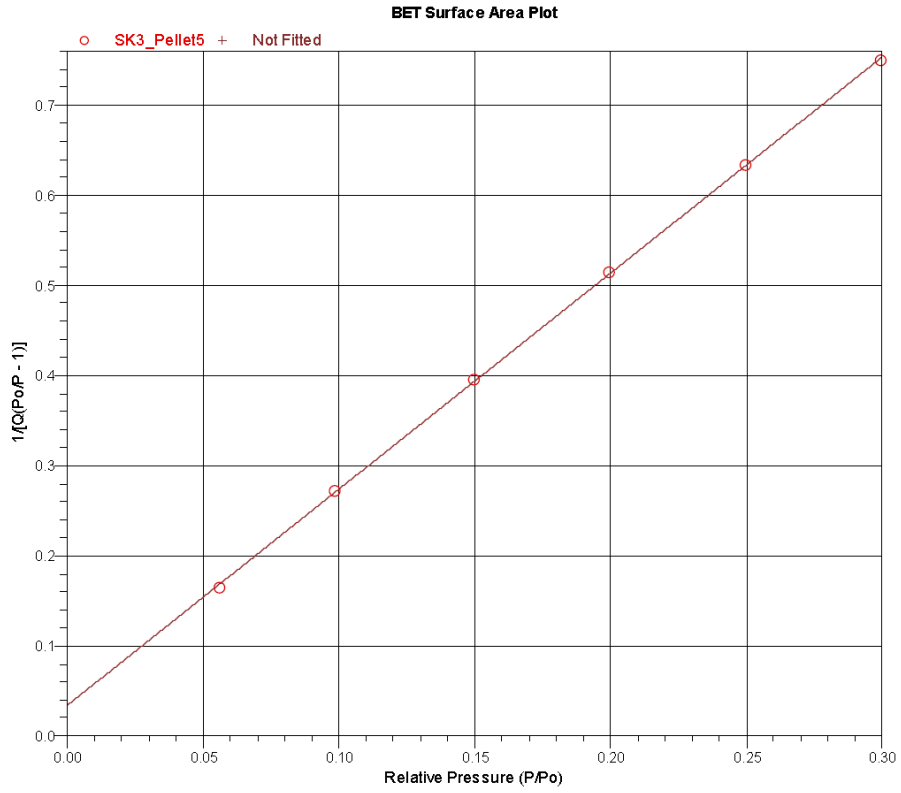
Started: 17.01.2018 15:35:21
Completed: 17.01.2018 16:53:09
Report Time: 17.01.2018 16:54:41
Sample Mass: 2,0019 g
Cold Free Space: 26,7502 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2151 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.7896 ± 0.0112 m²/g
Slope: 2.398327 ± 0.014878 g/cm³ STP
Y-Intercept: 0.033822 ± 0.002896 g/cm³ STP
C: 71.910143
Qm: 0,4112 cm³/g STP
Correlation Coefficient: 0.9999230
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.056032592	0.3609	0.164460
0.098709538	0.4030	0.271763
0.149655928	0.4449	0.395601
0.199687366	0.4846	0.514933
0.249705345	0.5256	0.633161
0.299689918	0.5709	0.749606



Sample: SK4_Pellet5
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\SK4_Pellet5.SMP

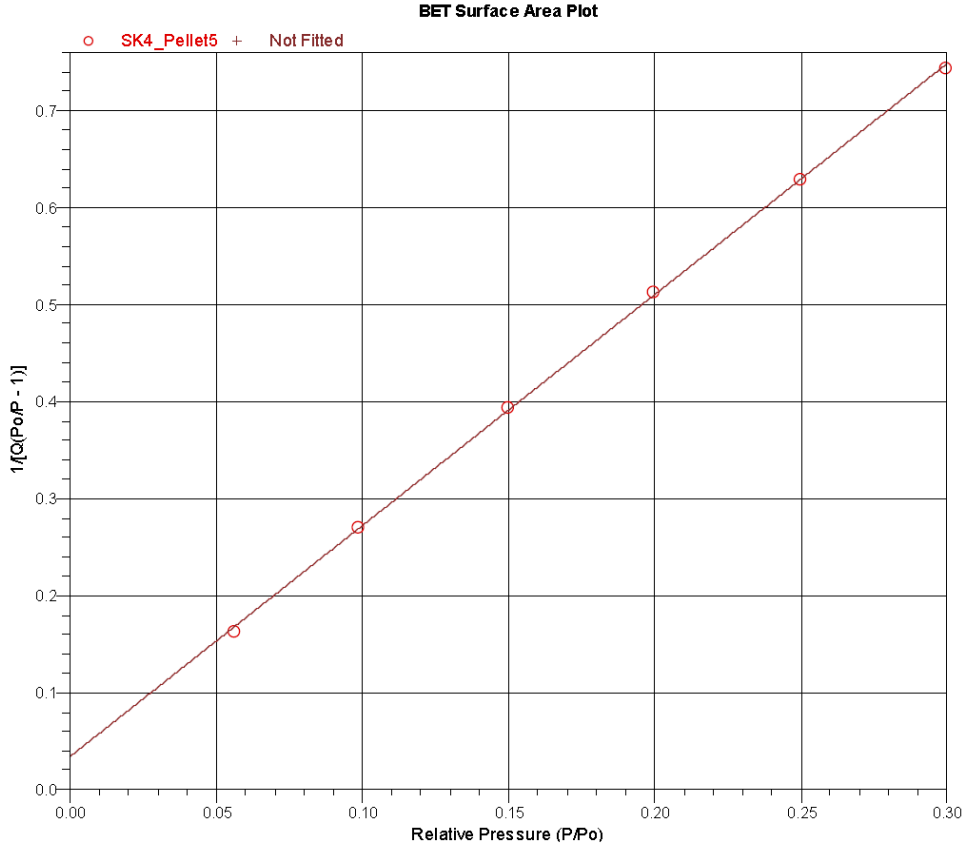
Started: 17.01.2018 15:35:21
Completed: 17.01.2018 16:53:09
Report Time: 17.01.2018 16:54:58
Sample Mass: 1,9453 g
Cold Free Space: 26,3497 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,1472 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.8022 ± 0.0127 m²/g
Slope: 2.381174 ± 0.016748 g/cm³ STP
Y-Intercept: 0.033934 ± 0.003260 g/cm³ STP
C: 71.169713
Qm: 0,4141 cm³/g STP
Correlation Coefficient: 0.9999011
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.056089701	0.3636	0.163416
0.098776823	0.4057	0.270181
0.149693532	0.4473	0.393588
0.199724769	0.4870	0.512464
0.249676599	0.5294	0.628616
0.299716415	0.5750	0.744331



Sample: SK5_Pellet5
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\SK5_Pellet5.SMP

Started: 17.01.2018 15:35:21
Completed: 17.01.2018 16:53:10
Report Time: 17.01.2018 16:54:17
Sample Mass: 1,9280 g
Cold Free Space: 27,4686 cm³
Low Pressure Dose: None
Automatic Degas: No

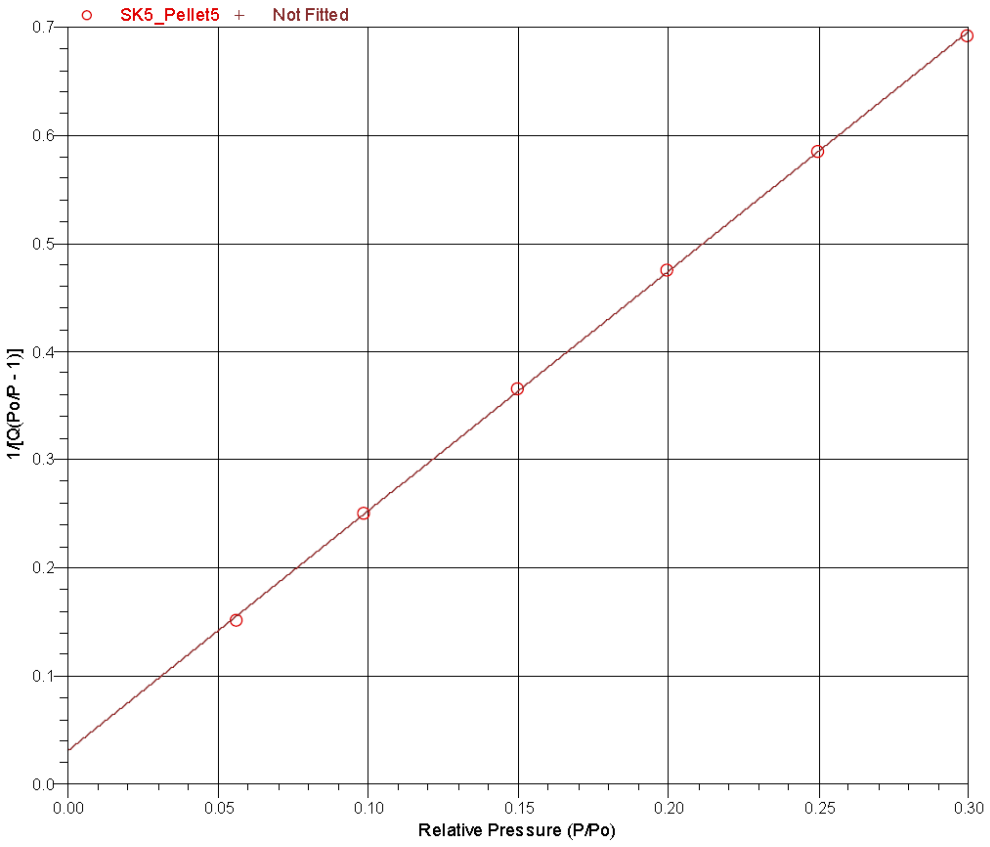
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,4102 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.9370 ± 0.0134 m²/g
Slope: 2.216106 ± 0.015312 g/cm³ STP
Y-Intercept: 0.030958 ± 0.002981 g/cm³ STP
C: 72.585010
Qm: 0,4450 cm³/g STP
Correlation Coefficient: 0.9999045
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055968035	0.3923	0.151139
0.098773377	0.4366	0.251011
0.149668260	0.4813	0.365707
0.199665897	0.5244	0.475764
0.249706114	0.5693	0.584573
0.299711456	0.6183	0.692205

BET Surface Area Plot



Different Core

Sample: M10_Pellet
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\M10_Pellet.SMP

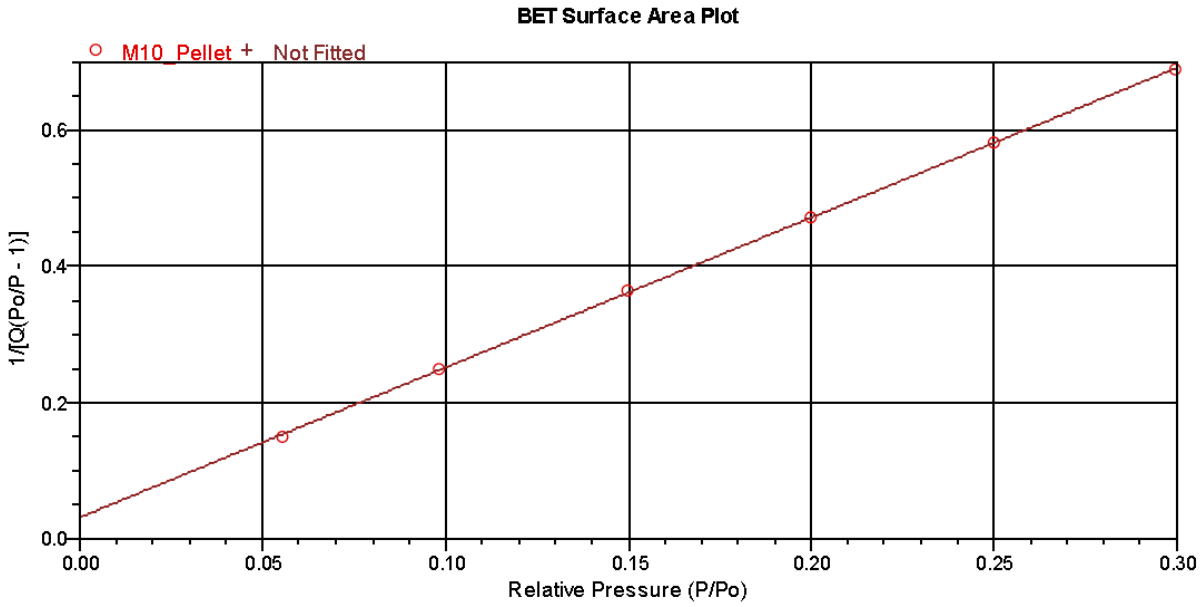
Started: 07.06.2018 13:08:42
Completed: 07.06.2018 14:29:30
Report Time: 07.06.2018 14:52:36
Sample Mass: 2,4590 g
Cold Free Space: 25,7081 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,9022 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.9483 ± 0.0111 m²/g
Slope: 2.203020 ± 0.012505 g/cm³ STP
Y-Intercept: 0.030980 ± 0.002433 g/cm³ STP
C: 72.110741
Qm: 0,4476 cm³/g STP
Correlation Coefficient: 0.9999356
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055293078	0.3914	0.149523
0.098336487	0.4383	0.248812
0.149610980	0.4845	0.363117
0.199662806	0.5278	0.472693
0.249721013	0.5729	0.580952
0.299730317	0.6211	0.689142



Degassed in 150°C

Sample: MON3_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\S...\MON3_Powder(2).SMP

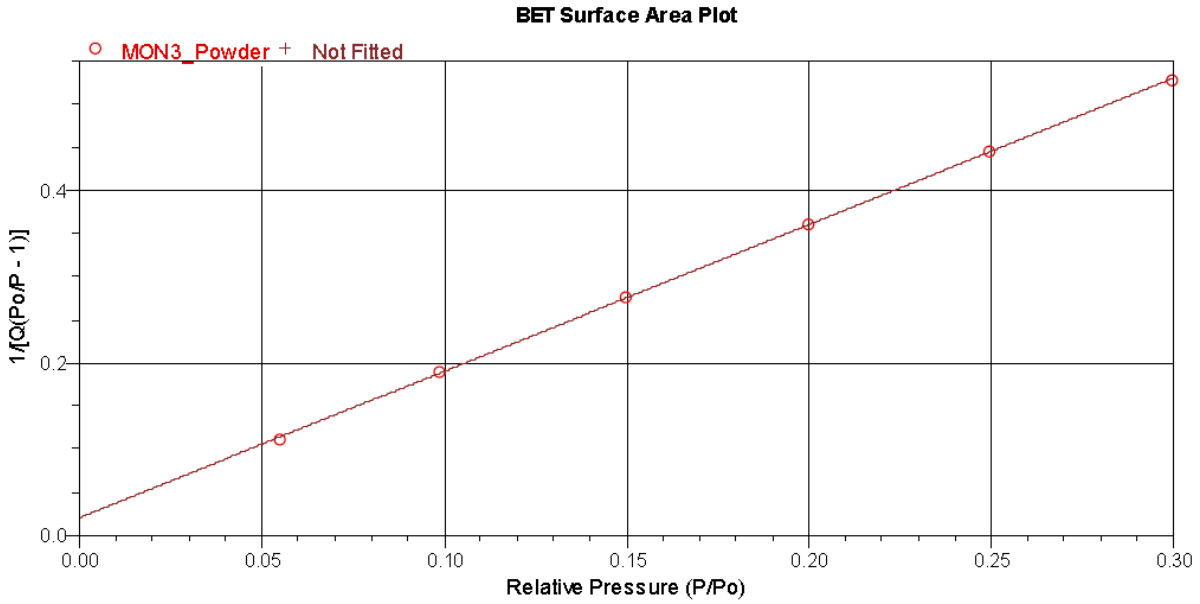
Started: 07.05.2018 17:44:57
Completed: 07.05.2018 19:22:57
Report Time: 07.05.2018 19:27:41
Sample Mass: 2,0808 g
Cold Free Space: 27,2067 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,3087 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 2.5313 ± 0.0152 m²/g
Slope: 1.698835 ± 0.010150 g/cm³ STP
Y-Intercept: 0.020634 ± 0.001974 g/cm³ STP
C: 83.330479
Qm: 0,5816 cm³/g STP
Correlation Coefficient: 0.9999286
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054961772	0.5222	0.111378
0.098462531	0.5784	0.188834
0.149529272	0.6354	0.276708
0.199617239	0.6905	0.361215
0.249668486	0.7480	0.444826
0.299612421	0.8105	0.527768



Sample: MOV5_Powder
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\S...\MOV5_Powder(2).SMP

Started: 07.05.2018 17:44:57
Completed: 07.05.2018 19:22:56
Report Time: 07.05.2018 19:27:52
Sample Mass: 2,1764 g
Cold Free Space: 26,7634 cm³
Low Pressure Dose: None
Automatic Degas: No

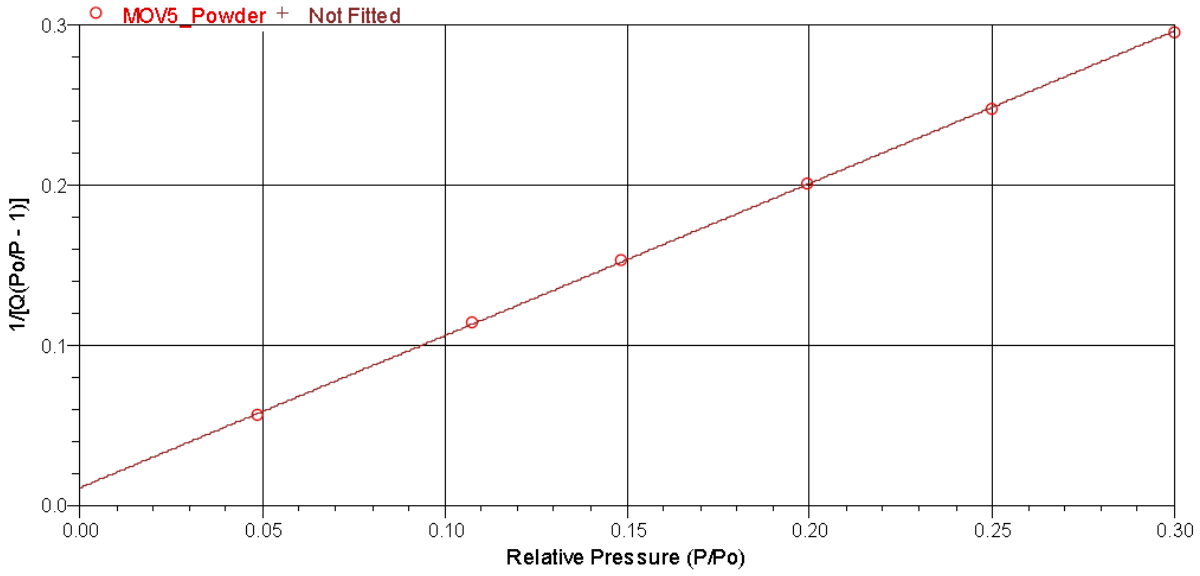
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,1689 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 4.5252 ± 0.0202 m²/g
Slope: 0.950770 ± 0.004223 g/cm³ STP
Y-Intercept: 0.011083 ± 0.000823 g/cm³ STP
C: 86.784380
Qm: 1,0397 cm³/g STP
Correlation Coefficient: 0.9999606
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.048732290	0.9107	0.056251
0.107436312	1.0552	0.114071
0.148367263	1.1389	0.152961
0.199579655	1.2400	0.201088
0.249754337	1.3413	0.248190
0.299765182	1.4477	0.295703

BET Surface Area Plot



Degassed in 300°C

Sample: 04CPA
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\04CPA.SMP

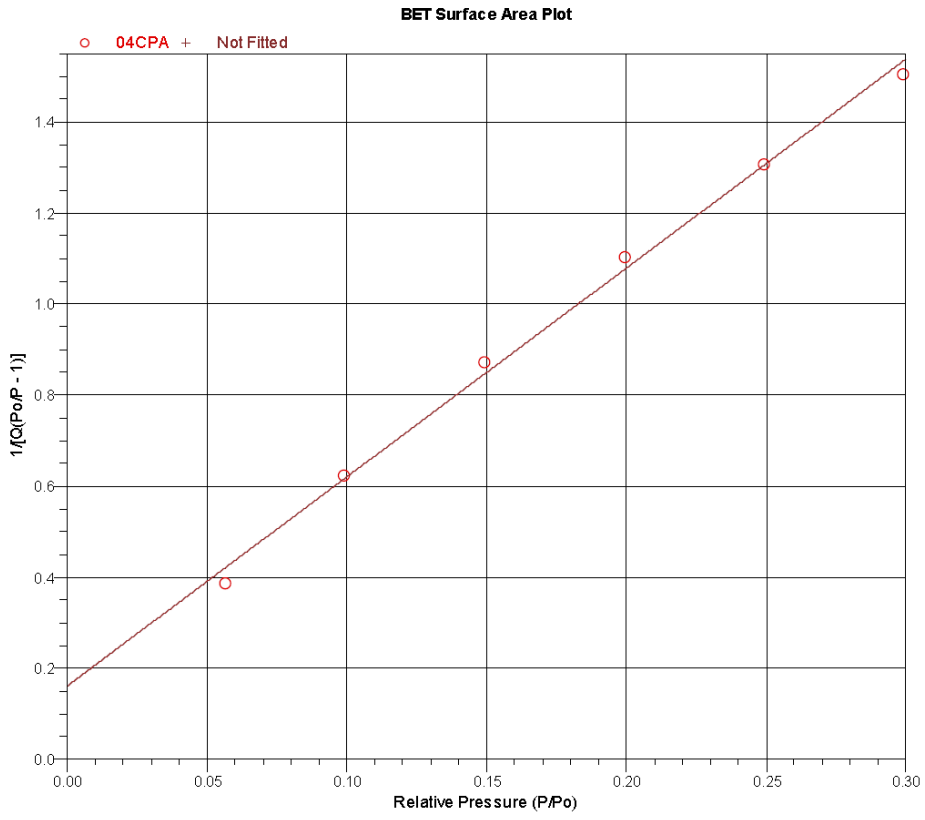
Started: 07.03.2018 15:53:10
Completed: 07.03.2018 17:57:57
Report Time: 07.03.2018 17:59:36
Sample Mass: 2,0650 g
Cold Free Space: 25,9175 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 8,9941 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 0.9161 ± 0.0278 m²/g
Slope: 4.590320 ± 0.141678 g/cm³ STP
Y-Intercept: 0.161015 ± 0.027546 g/cm³ STP
C: 29.508565
Qm: 0,2105 cm³/g STP
Correlation Coefficient: 0.9981002
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.056664372	0.1549	0.387760
0.099034727	0.1765	0.622699
0.149408402	0.2012	0.873124
0.199451550	0.2259	1.102697
0.249323590	0.2539	1.308113
0.299212544	0.2836	1.505743



Sample: 05CPL
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\05CPL.SMP

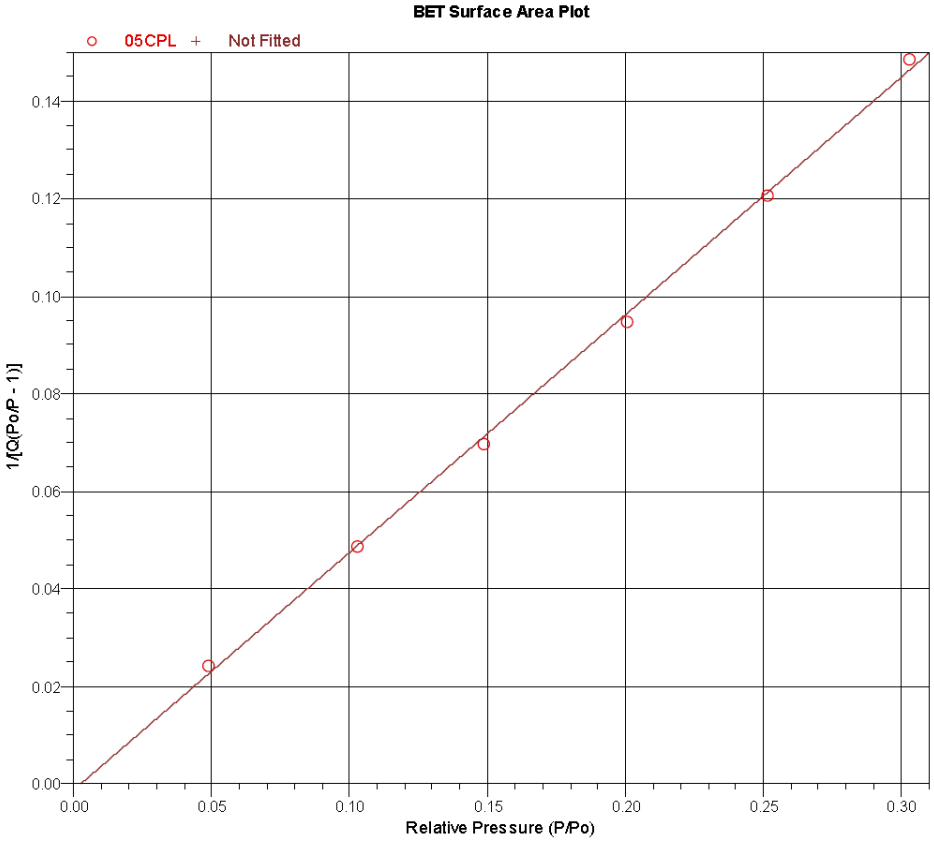
Started: 07.03.2018 18:12:07
Completed: 07.03.2018 19:52:23
Report Time: 07.03.2018 19:52:43
Sample Mass: 2,0417 g
Cold Free Space: 27,4501 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,4041 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 8.9518 ± 0.1697 m²/g
Slope: 0.487511 ± 0.009043 g/cm³ STP
Y-Intercept: -0.001286 ± 0.001771 g/cm³ STP
C: -378.216457
Qm: 2,0567 cm³/g STP
Correlation Coefficient: 0.9993125
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.048721970	2.1089	0.024286
0.102576130	2.3504	0.048631
0.148458975	2.5012	0.069704
0.200601699	2.6511	0.094656
0.251564476	2.7880	0.120559
0.302766950	2.9217	0.148624



Sample: 09BE
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\09BE.SMP

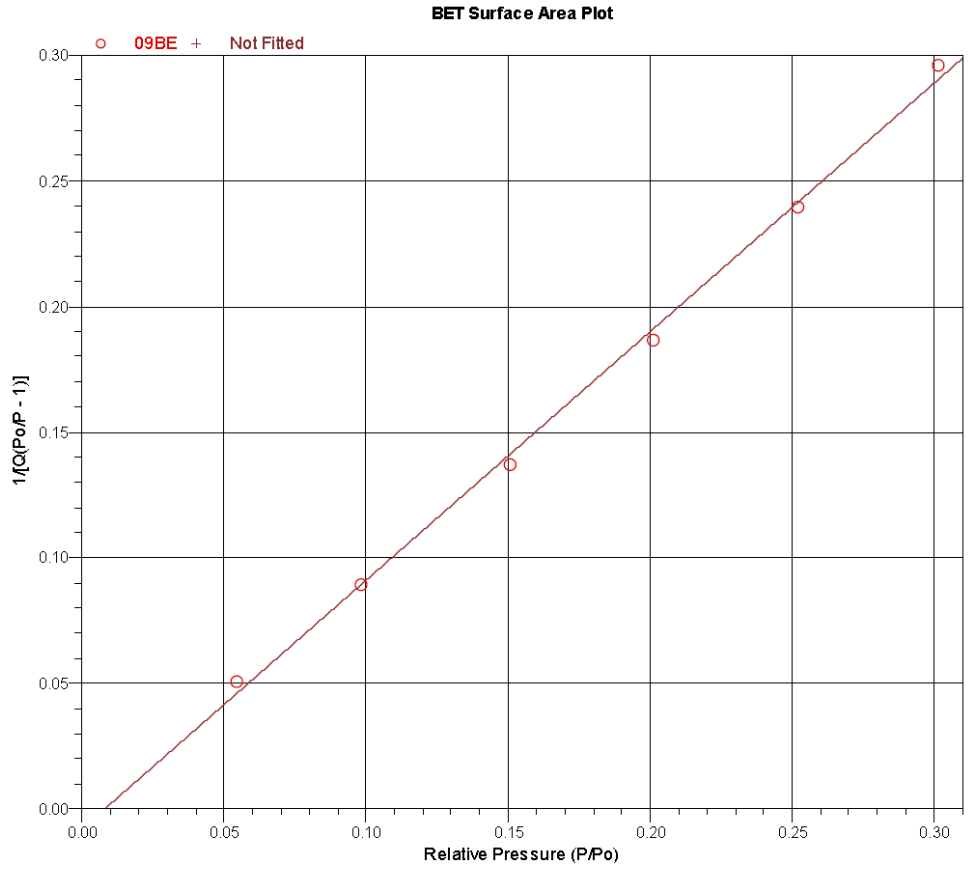
Started: 07.03.2018 20:01:39
Completed: 07.03.2018 21:20:21
Report Time: 07.03.2018 21:21:17
Sample Mass: 2,0619 g
Cold Free Space: 27,7067 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,5060 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 4.4335 ± 0.1062 m²/g
Slope: 0.989681 ± 0.023088 g/cm³ STP
Y-Intercept: -0.007936 ± 0.004521 g/cm³ STP
C: -123.705664
Qm: 1,0186 cm³/g STP
Correlation Coefficient: 0.9989133
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.054291681	1.1365	0.050511
0.098442306	1.2223	0.089332
0.150612684	1.2923	0.137208
0.201186736	1.3499	0.186570
0.251739834	1.4044	0.239562
0.301394954	1.4577	0.295953



Sample: 12CPA2
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\12CPA2.SMP

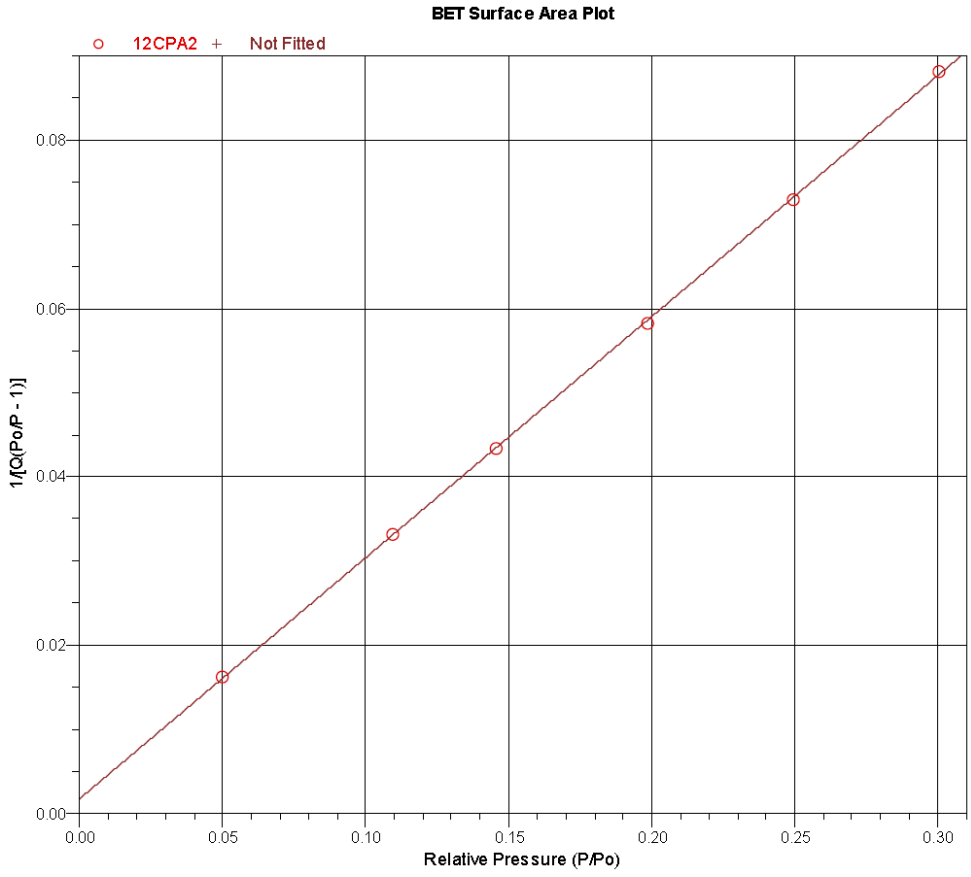
Started: 07.03.2018 18:12:07
Completed: 07.03.2018 19:52:22
Report Time: 07.03.2018 19:52:58
Sample Mass: 2,0631 g
Cold Free Space: 26,8612 cm³
Low Pressure Dose: None
Automatic Degas: No

Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2046 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 15.1079 ± 0.0903 m²/g
Slope: 0.286327 ± 0.001690 g/cm³ STP
Y-Intercept: 0.001773 ± 0.000329 g/cm³ STP
C: 162.524092
Qm: 3,4710 cm³/g STP
Correlation Coefficient: 0.9999303
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.049699170	3.2292	0.016196
0.109368225	3.6979	0.033208
0.145625564	3.9325	0.043343
0.198557112	4.2531	0.058252
0.249197726	4.5557	0.072855
0.300167669	4.8644	0.088175



Sample: 13AR
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\13AR.SMP

Started: 07.03.2018 18:12:07
Completed: 07.03.2018 19:52:22
Report Time: 07.03.2018 19:53:09
Sample Mass: 2,0664 g
Cold Free Space: 27,1400 cm³
Low Pressure Dose: None
Automatic Degas: No

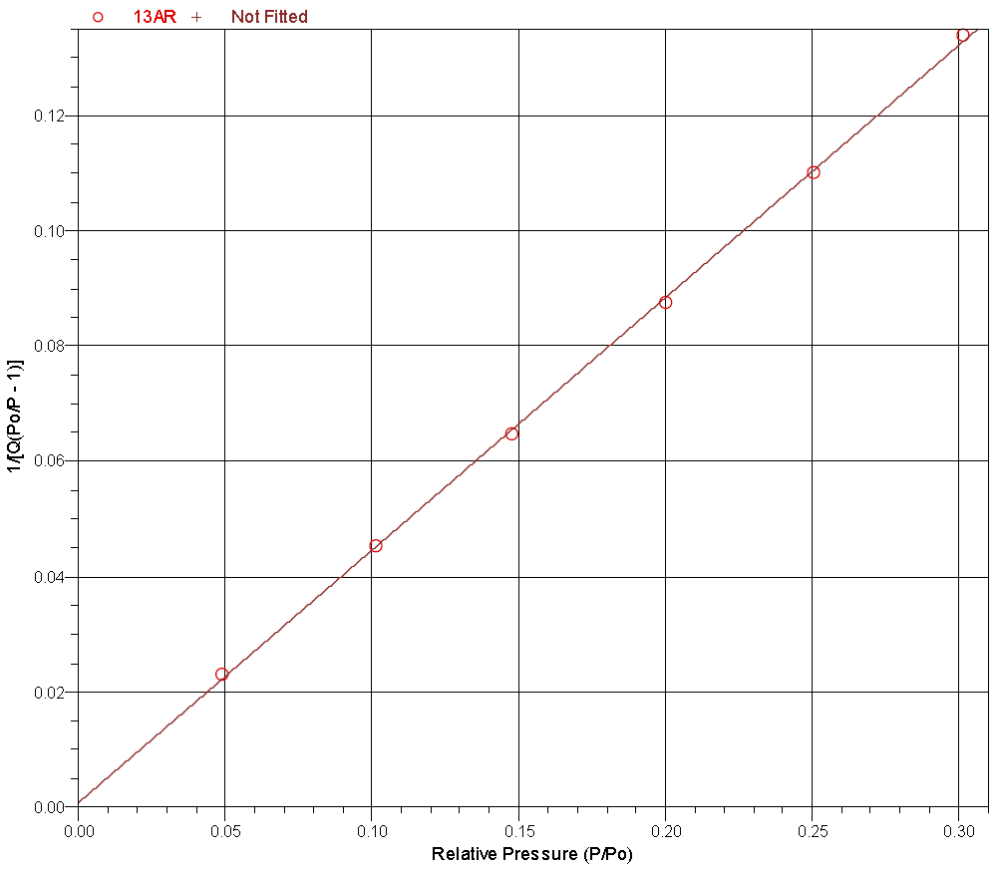
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2999 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 9.9171 ± 0.1028 m²/g
Slope: 0.438116 ± 0.004467 g/cm³ STP
Y-Intercept: 0.000781 ± 0.000871 g/cm³ STP
C: 562.220207
Qm: 2,2784 cm³/g STP
Correlation Coefficient: 0.9997921
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.048854831	2.2323	0.023010
0.101406155	2.4936	0.045257
0.147526191	2.6722	0.064763
0.199983782	2.8583	0.087455
0.250540380	3.0362	0.110104
0.301260863	3.2192	0.133930

BET Surface Area Plot



Sample: 016CHU
Operator:
Submitter:
File: C:\TriStar II 3020\data\Rowena\016CHU.SMP

Started: 07.03.2018 15:53:10
Completed: 07.03.2018 17:57:57
Report Time: 07.03.2018 17:59:25
Sample Mass: 2,0735 g
Cold Free Space: 26,7913 cm³
Low Pressure Dose: None
Automatic Degas: No

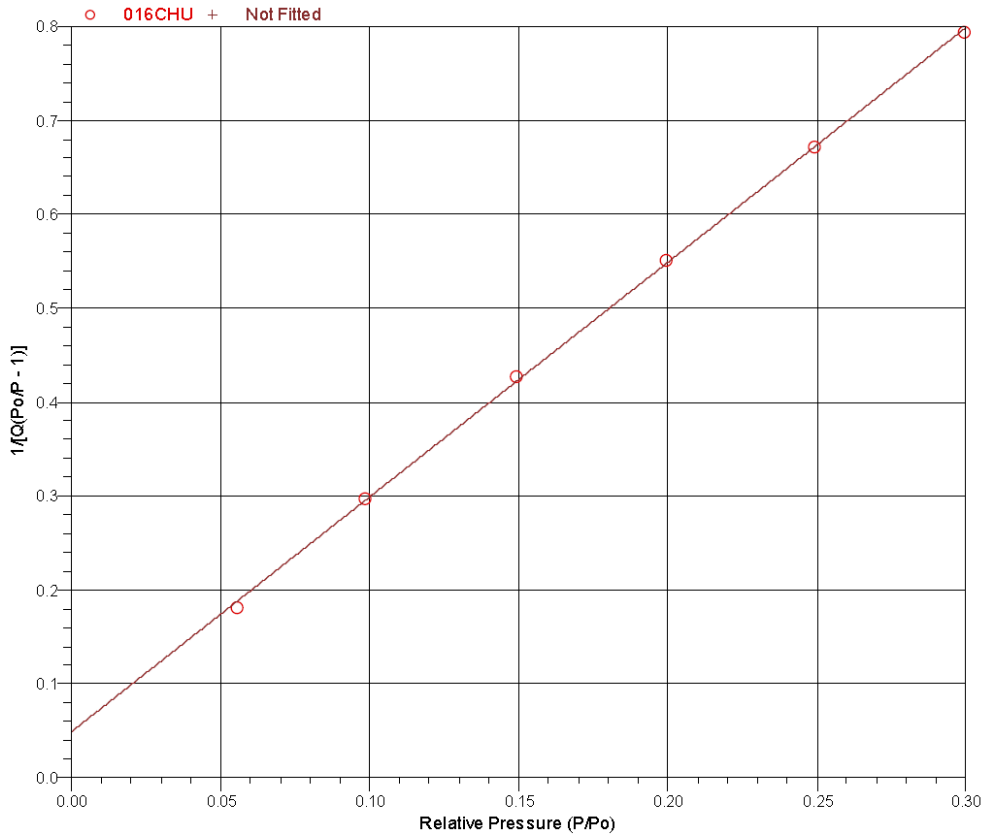
Analysis Adsorptive: N2
Analysis Bath Temp.: -195,850 °C
Thermal Correction: No
Warm Free Space: 9,2716 cm³ Measured
Equilibration Interval: 10 s
Sample Density: 1,000 g/cm³

BET Report

BET Surface Area: 1.7080 ± 0.0177 m²/g
Slope: 2.499504 ± 0.025974 g/cm³ STP
Y-Intercept: 0.048788 ± 0.005050 g/cm³ STP
C: 52.231647
Qm: 0,3924 cm³/g STP
Correlation Coefficient: 0.9997841
Molecular Cross-Sectional Area: 0.1620 nm²

Relative Pressure (P/Po)	Quantity Adsorbed (cm³/g STP)	1/[Q(Po/P - 1)]
0.055409124	0.3249	0.180547
0.098482444	0.3675	0.297288
0.149454273	0.4108	0.427743
0.199481416	0.4520	0.551253
0.249408119	0.4947	0.671747
0.299543076	0.5392	0.793077

BET Surface Area Plot



I. SSA Results for Spain Samples in 2013

Sample	SSA Result (m^2/g)
SAL3	3.936
HE14	2.961
LD	1.229
L13	1.388
G18	2.439
OV7	4.238
B4	1.218
BT	12.936
SP7	6.077
LV3	0.665
CollaD	3.827
SLL	3.027
HU7	7.809
Portilla	2.584
SE6	6.762
Gijón	3.216
Rodiles	10.979
Vega	1.854
VC	2.184

J. Data Compilation

Sample	SSA (m^2/g)	Uncertainties (+/-)	Density (g/cm^3)	Porosity (%)	Permeability (m^2)	Grain Size	Rock Type	Formation	Age	Comment	Previous Result / Work
A1_Pellet	3.8795	0.0114	1.24	46.50	2.17237E-15	Clay/Very Fine Silt (Carbonate)	Chalk	Tor Formation	Maastrichtian		
A1_Powder	3.9960	0.0141	1.24	46.50	2.04755E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
A2_Pellet	3.8432	0.0105	1.24	46.50	2.2136E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
A2_Powder	3.9358	0.0117	1.24	46.50	2.11067E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
A3_Pellet	3.7005	0.0185	1.24	46.50	2.38762E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
A3_Powder	4.0128	0.0178	1.24	46.50	2.03044E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
A4_Pellet	3.2403	0.0153	1.24	46.50	3.11397E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
A4_Powder	3.7649	0.0139	1.24	46.50	2.30663E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
A5_Pellet	3.2084	0.0163	1.24	46.50	3.1762E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
	3.2403	0.0153	1.24	46.50	3.11397E-15	Clay/Very Fine Silt (Carbonate)	Chalk			2nd attempt for accuracy	
A5_Powder	3.5009	0.0152	1.24	46.50	2.66763E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
K1_Pellet	2.3790	0.0202	1.24	37.00	2.91033E-15	Clay/Very Fine Silt (Carbonate)	Chalk	Niobrara Formation	Late Cretaceous		
	2.3362	0.0198	1.24	37.00	3.01795E-15	Clay/Very Fine Silt (Carbonate)	Chalk			2nd attempt for accuracy	
K1_Powder	2.7020	0.0233	1.24	37.00	2.25611E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
K2_Pellet	2.7169	0.0121	1.24	37.00	2.23144E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
K2_Powder	3.0628	0.0162	1.24	37.00	1.75588E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
K3_Pellet	2.6241	0.0111	1.24	37.00	2.39205E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
K3_Powder	2.9223	0.0178	1.24	37.00	1.92878E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
K4_Pellet	2.6183	0.0091	1.24	37.00	2.40266E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
K4_Powder	2.9378	0.0142	1.24	37.00	1.90848E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
K5_Pellet	2.6147	0.0120	1.24	37.00	2.40928E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
K5_Powder	2.9583	0.0177	1.24	37.00	1.88212E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
KA8-3(F)	2.6893	0.0319	1.24	37.00	2.27747E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
KA8-7(F)	2.0445	0.0410	1.24	37.00	3.94056E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
L1_Pellet	2.5984	0.0218	1.10	43.30	4.96863E-15	Clay/Very Fine Silt (Carbonate)	Chalk	Gulpen Formation	Campanian		**SSA**
L1_Powder	2.9237	0.0251	1.10	43.30	3.92449E-15	Clay/Very Fine Silt (Carbonate)	Chalk				Liège 1.1-1.7 | Liège 2.1-2.7 | Liège 3.1-3.7
L2_Pellet	2.6157	0.0210	1.10	43.30	4.90312E-15	Clay/Very Fine Silt (Carbonate)	Chalk				**Pellet**
L2_Powder	2.9379	0.0246	1.10	43.30	3.88664E-15	Clay/Very Fine Silt (Carbonate)	Chalk				2.1182 +/- 0.0209 | 2.1595 +/- 0.0193 | 2.2216 +/- 0.0177
L3_Pellet	2.7667	0.0218	1.10	43.30	4.38252E-15	Clay/Very Fine Silt (Carbonate)	Chalk				2.0364 +/- 0.0211 | 2.0814 +/- 0.0199 | 2.0654 +/- 0.0187
L3_Powder	3.0867	0.0217	1.10	43.30	3.52095E-15	Clay/Very Fine Silt (Carbonate)	Chalk				2.0977 +/- 0.0216 | 2.153 +/- 0.0203 | 2.1954 +/- 0.0179
L4_Pellet	2.9163	0.0247	1.10	43.30	3.94443E-15	Clay/Very Fine Silt (Carbonate)	Chalk				2.0705 +/- 0.0238 | 2.1768 +/- 0.0242 | 2.1768 +/- 0.0211
L4_Powder	3.1822	0.0241	1.10	43.30	3.31279E-15	Clay/Very Fine Silt (Carbonate)	Chalk				2.0549 +/- 0.0242 | 2.1288 +/- 0.0223 | 2.1187 +/- 0.0207
L5_Pellet	2.6618	0.0224	1.10	43.30	4.73475E-15	Clay/Very Fine Silt (Carbonate)	Chalk				**Powder**
L5_Powder	3.0251	0.0258	1.10	43.30	3.6658E-15	Clay/Very Fine Silt (Carbonate)	Chalk				2.256 +/- 0.0305 | 2.2356 +/- 0.0291 | 2.2615 +/- 0.0268
L1-1(F)	5.0301	0.0392	1.10	43.30	1.32585E-15	Clay/Very Fine Silt (Carbonate)	Chalk				2.1714 +/- 0.025 | 2.1779 +/- 0.0233 | 2.242 +/- 0.0268
L1-7(F)	2.8264	0.0384	1.10	43.30	4.19934E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MON1_Pellet	2.0662	0.0111	1.21	43.30	6.49409E-15	Clay/Very Fine Silt (Carbonate)	Chalk	Nouvelles Formation	Campanian		
MON1_Powder	2.2727	0.0110	1.21	43.30	5.36758E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MON2_Pellet	2.1666	0.0071	1.21	43.30	5.90616E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MON2_Powder	2.4313	0.0146	1.21	43.30	4.69014E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MON3_Pellet	2.2918	0.0073	1.21	43.30	5.27849E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MON3_Powder	2.4592	0.0125	1.21	43.30	4.58432E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
	2.5313	0.0152	1.21	43.30	4.32689E-15	Clay/Very Fine Silt (Carbonate)	Chalk			Degassed with 150℃	
MON4_Pellet	2.0688	0.0078	1.21	43.30	6.47778E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MON4_Powder	2.2457	0.0088	1.21	43.30	5.49743E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MON5_Pellet	1.9090	0.0104	1.21	43.30	7.60766E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MON5_Powder	2.1095	0.0143	1.21	43.30	6.23023E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MOV1_Pellet	4.1194	0.0123	1.25	40.10	1.21595E-15	Clay/Very Fine Silt (Carbonate)	Chalk	Saint Vaast Formation	Campanian		
MOV1_Powder	4.5022	0.0110	1.25	40.10	1.01797E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MOV2_Pellet	4.2044	0.0111	1.25	40.10	1.16728E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MOV2_Powder	4.5871	0.0114	1.25	40.10	9.80633E-16	Clay/Very Fine Silt (Carbonate)	Chalk				
MOV3_Pellet	4.1459	0.0163	1.25	40.10	1.20045E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MOV3_Powder	4.4450	0.0114	1.25	40.10	1.04433E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MOV4_Pellet	4.0986	0.0133	1.25	40.10	1.22832E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MOV4_Powder	4.4864	0.0108	1.25	40.10	1.02515E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MOV5_Pellet	4.3004	0.0117	1.25	40.10	1.11575E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MOV5_Powder	4.5434	0.0151	1.25	40.10	9.99588E-16	Clay/Very Fine Silt (Carbonate)	Chalk				
	4.5252	0.0202	1.25	40.10	1.00764E-15	Clay/Very Fine Silt (Carbonate)	Chalk			Degassed with 150°C	
MS1_Pellet	2.5817	0.0042	1.08	40.27	4.20006E-15	Clay/Very Fine Silt (Carbonate)	Chalk	Spiennes Formation	Campanian		
MS1_Powder	2.6921	0.0089	1.08	40.27	3.86265E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MS2_Pellet	2.7572	0.0048	1.08	40.27	3.6824E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MS2_Powder	2.8811	0.0081	1.08	40.27	3.37249E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MS3_Pellet	2.8034	0.0057	1.08	40.27	3.56203E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MS3_Powder	3.0166	0.0088	1.08	40.27	3.07632E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MS4_Pellet	2.6963	0.0046	1.08	40.27	3.85062E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
	2.6309	0.0044	1.08	40.27	4.04444E-15	Clay/Very Fine Silt (Carbonate)	Chalk			2nd attempt for accuracy	
MS4_Powder	2.8705	0.0066	1.08	40.27	3.39744E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MS5_Pellet	2.8069	0.0063	1.08	40.27	3.55315E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MS5_Powder	2.9431	0.0065	1.08	40.27	3.2319E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MT1_Pellet	1.8185	0.0165	1.22	41.00	7.00125E-15	Clay/Very Fine Silt (Carbonate)	Chalk	Trivières Formation	Campanian		
MT1_Powder	2.0981	0.0160	1.22	41.00	5.25956E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MT2_Pellet	1.8366	0.0128	1.22	41.00	6.86393E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MT2_Powder	2.1582	0.0175	1.22	41.00	4.97071E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MT3_Pellet	1.8136	0.0143	1.22	41.00	7.03913E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MT3_Powder	2.1326	0.0163	1.22	41.00	5.09077E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MT4_Pellet	1.8058	0.0160	1.22	41.00	7.10007E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MT4_Powder	2.1039	0.0174	1.22	41.00	5.2306E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MT5_Pellet	1.6542	0.0160	1.22	41.00	8.46108E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MT5_Powder	1.9851	0.0192	1.22	41.00	5.8754E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
MON10	1.9483	0.0111	1.22	41.00	6.09944E-15	Clay/Very Fine Silt (Carbonate)	Chalk				
SK1_Pellet	1.8972	0.0113	1.19	46.50	9.86299E-15	Clay/Very Fine Silt (Carbonate)	Chalk	Tor Formation	Maastrichtian	1st attempt with 1 gram	**SSA**
	2.0713	0.0472	1.19	46.50	8.27464E-15	Clay/Very Fine Silt (Carbonate)	Chalk			2nd attempt with 2 grams	SK 1.1 - 1.6 | SK 2.1 - 2.6 | SK 3.1 - 3.6
SK1_Powder	2.1185	0.0161	1.19	46.50	7.91003E-15	Clay/Very Fine Silt (Carbonate)	Chalk				**Pellet**
SK2_Pellet	1.8990	0.0406	1.19	46.50	9.8443E-15	Clay/Very Fine Silt (Carbonate)	Chalk			1st attempt with 2 grams	1.9081 +/- 0.0246 | 1.9408 +/- 0.0314 | 1.8425 +/- 0.0268
	1.7853	0.0156	1.19	46.50	1.11381E-14	Clay/Very Fine Silt (Carbonate)	Chalk			2nd attempt with 1 gram	1.8771 +/- 0.0242 | 1.9162 +/- 0.0287 | 1.8588 +/- 0.0268
SK2_Powder	2.0553	0.0192	1.19	46.50	8.40397E-15	Clay/Very Fine Silt (Carbonate)	Chalk				1.8904 +/- 0.0271 | 1.9166 +/- 0.0335 | 1.9085 +/- 0.0317
SK3_Pellet	1.8064	0.0125	1.19	46.50	1.08795E-14	Clay/Very Fine Silt (Carbonate)	Chalk				1.8686 +/- 0.0245 | 1.8764 +/- 0.0290 | 2.3362 +/- 0.0290
	1.7896	0.0112	1.19	46.50	1.10847E-14	Clay/Very Fine Silt (Carbonate)	Chalk			5 hours of Degassing	**Powder**
SK3_Powder	1.9555	0.0162	1.19	46.50	9.28366E-15	Clay/Very Fine Silt (Carbonate)	Chalk				2.0480 +/- 0.0205 | 2.0518 +/- 0.0253 | 2.1050 +/- 0.0268
SK4_Pellet	1.8926	0.0132	1.19	46.50	9.911E-15	Clay/Very Fine Silt (Carbonate)	Chalk				2.1003 +/- 0.0235 | 2.1013 +/- 0.0285 | 2.1566 +/- 0.0291
	1.8022	0.0127	1.19	46.50	1.09302E-14	Clay/Very Fine Silt (Carbonate)	Chalk			5 hours of Degassing	

SK4_Powder	1.9993	0.0180	1.19	46.50	8.88135E-15	Clay/Very Fine Silt (Carbonate)	Chalk					
SK5_Pellet	1.9453	0.0161	1.19	46.50	9.38127E-15	Clay/Very Fine Silt (Carbonate)	Chalk					
	1.9370	0.0134	1.19	46.50	9.46184E-15	Clay/Very Fine Silt (Carbonate)	Chalk			5 hours of Degassing		
SK5_Powder	2.1053	0.0181	1.19	46.50	8.00953E-15	Clay/Very Fine Silt (Carbonate)	Chalk					
MAT 52	1.6743	0.0062	2.93	-	-	Clay/Very Fine Silt (Carbonate)	Chalk	Mattinata	Cretaceous			
MAT K9	0.3337	0.0159	1.88	7.36	5.06495E-16	Clay/Very Fine Silt (Carbonate)	Chalk					
MAT K6	2.4371	0.0270	1.83	6.90	8.25788E-18	Clay/Very Fine Silt (Carbonate)	Chalk					
MAT K2	0.6070	0.0150	1.91	28.45	8.56589E-15	Clay/Very Fine Silt (Carbonate)	Chalk					
MAT K35	2.5548	0.0113	0.97	18.00	4.74821E-16	Clay/Very Fine Silt (Carbonate)	Chalk					
MAT K1	0.8537	0.0131	1.36	4.37	3.09547E-17	Clay/Very Fine Silt (Carbonate)	Chalk					
W23	1.3394	0.0098	1.73	8.44	5.59867E-17	Clay/Very Fine Silt (Carbonate)	Chalk	Ulster White Limestone	Late Cretaceous			
W19	0.6050	0.0128	2.68	4.91	2.2513E-17	Clay/Very Fine Silt (Carbonate)	Chalk					
W9	0.5932	0.0107	3.30	1.23	2.42804E-19	Clay/Very Fine Silt (Carbonate)	Chalk					
W16	1.1634	0.0115	2.18	17.36	4.06676E-16	Clay/Very Fine Silt (Carbonate)	Chalk					
W10	0.7185	0.0104	1.84	1.45	8.72137E-19	Clay/Very Fine Silt (Carbonate)	Chalk					
W24	0.9269	0.0079	2.06	1.08	1.72759E-19	Clay/Very Fine Silt (Carbonate)	Chalk					
W18	0.7694	0.0116	1.83	11.22	3.56239E-16	Clay/Very Fine Silt (Carbonate)	Chalk					
W3	1.2683	0.0030	1.52	2.36	1.76838E-18	Clay/Very Fine Silt (Carbonate)	Chalk					
W15	0.9286	0.0141	1.37	11.55	4.76012E-16	Clay/Very Fine Silt (Carbonate)	Chalk					
W27	0.9363	0.0099	2.80	5.30	1.08306E-17	Clay/Very Fine Silt (Carbonate)	Chalk					
W20	0.7895	0.0086	1.48	7.44	1.50821E-16	Clay/Very Fine Silt (Carbonate)	Chalk					
W13	2.0238	0.0098	1.18	12.91	1.88647E-16	Clay/Very Fine Silt (Carbonate)	Chalk					
VE37	1.8419	0.0392	1.40	37.00	3.80879E-15	Clay/Very Fine Silt (Carbonate)	Chalk	Tor	Maastrichtian			
VE27	2.9240	0.0479	1.20	13.00	8.92242E-17	Clay/Very Fine Silt (Carbonate)	Chalk	Tor	Maastrichtian			
VE34	1.2781	0.0053	1.22	13.00	4.51805E-16	Clay/Very Fine Silt (Carbonate)	Chalk	Tor	Maastrichtian			
VE13	1.5820	0.0161	1.36	18.00	6.29936E-16	Clay/Very Fine Silt (Carbonate)	Chalk	Hod	Campanian			
VE50	0.7951	0.0159	1.15	19.00	4.10196E-15	Clay/Very Fine Silt (Carbonate)	Chalk	Tor	Maastrichtian			
VE30	1.4728	0.0248	1.69	15.00	2.72385E-16	Clay/Very Fine Silt (Carbonate)	Chalk	Tor	Maastrichtian			
VE29	1.1930	0.0235	1.64	9.00	9.52202E-17	Clay/Very Fine Silt (Carbonate)	Chalk	Tor	Maastrichtian			
01CV1	0.5997	0.0148	2.57	1.77	1.16723E-18	medium silt - medium sand	Sandstone	Catavi	Late Silurian			
02CV2	0.4383	0.0280	2.64	0.71	1.33658E-19	medium silt (crystalline & interlocking grains)	Sandstone					
03CV3	0.8248	0.0151	2.71	0.59	2.05537E-20	fine - medium silt (little crystallized)	Sandstone					
04CPA	0.9161	0.0278	2.66	0.68	2.64757E-20	fine - very coarse sand (crystalline & interlocking)	Sandstone	Copacabana (Sandstone)	Late Carboniferous - Mid Permian	Degassed 3 1/2 hours in 300°C		
	0.8654	0.0176	2.66	0.68	2.96688E-20							
05CPL	8.9518	0.1697	2.30	13.65	2.99979E-18	medium silt	Shale	Copacabana (Siltstone)	Late Carboniferous - Mid Permian	Degassed 3 1/2 hours in 300°C		
	5.2564	0.0413	2.30	13.65	8.70032E-18							
06CM	7.0066	0.0884	2.66	2.24	1.61784E-20	medium -coarse silt	Diamictites / Tillite	Cumaná	Late Devonian			
08UN	1.9016	0.0113	2.78	0.76	7.85385E-21	fine silt	Shale	Uncía	Late Silurian - Devonian			
09BE	4.4335	0.1062	2.54	4.79	4.33327E-19	very fine - fine sand	Sandstone	Belén	Devonian	Degassed 3 1/2 hours in 300°C		
	2.1450	0.0086	2.54	4.79	1.85121E-18		Sandstone					
10CNC	0.2951	0.0391	2.65	13.62	2.06572E-15	very fine - fine sand (crystallized & interlocking)	Diamictites / Tillite	Cancañiri	Early Silurian			
11TQ	4.1357	0.0175	2.55	9.99	4.48217E-18	medium silt - medium sand	Sandstone	Tiquina	Early Triassic			
12CPA2	15.1079	0.0903	2.43	9.00	2.70444E-19	very fine - fine silt	Sandstone	Copacabana (Sandstone)	Late Carboniferous - Mid Permian	Degassed 3 1/2 hours in 300°C		
	9.0423	0.0481	2.43	9.00	7.54966E-19							
13AR	9.9171	0.1028	2.41	10.22	9.34371E-19	fine silt	Sandstone	Aranjuéz	Mid Tertiary	Degassed 3 1/2 hours in 300°C		
	6.8920	0.0212	2.41	10.22	1.93463E-18							
14CL	3.9431	0.0780	2.53	5.80	9.80251E-19	fine - coarse silt (little crystallized)	Sandstone	Colpacucho	Late Devonian			
15CHD	1.4938	0.0180	2.64	0.62	7.66218E-21	very fine - fine silt	Sandstone	Chutani (Base)	Permian			
016CHU	1.7080	0.0177	2.71	1.46	7.26297E-20	very fine silt - fine sand	Sandstone	Chutani (Top)		Degassed 3 1/2 hours in 300°C		
	2.1104	0.0086	2.71	1.46	4.7573E-20							
075C	2.7591	0.0268	2.58	4.12	6.90061E-19	Coarse silt - very fine sand, crystalline	Sandstone	Sica Sica	Devonian			
SAL3	2.9821	0.0199	2.62	2.50	1.27701E-19	very fine - medium silt	Sandstone	Mora	Ediacaran		3.936 (SSA)	5.2E-19 (MP)	3.3E-19 (CP)
HE14	18.9468	0.4684	2.35	11.47	3.8156E-19	medium - coarse sand (little crystallized)	Sandstone	Herrería	Cambrian		2.961 (SSA)	5.535E-17 (MP)	2.287E-17 (CP)
LD	1.7190	0.0116	2.87	0.69	6.88084E-21	very fine - fine silt	Dolomite	Láncara			1.229 (SSA)	8.2E-19 (MP)	1.35E-21 (CP)
L13	1.2069	0.0127	2.72	0.70	1.56775E-20	medium silt - very fine sand	Limestone				1.388 (SSA)	4.79E-20 (MP)	1.19E-21 (CP)
G18	3.7092	0.0286	2.71	0.92	3.81073E-21	coarse silt - granules	Griotte				2.439 (SSA)	2.79E-21 (MP)	8.81E-21 (CP)
OV7	9.7963	0.1082	2.45	7.38	3.4917E-19	clay (shale)	Shale	Oville			4.238 (SSA)	1.51E-18 (MP)	2.3E-18 (CP)
B4	1.2314	0.0085	2.53	1.41	1.44521E-19	very fine - fine sand (crystallized)	Quartz Arenite	Barrios			1.218 (SSA)	5.6E-19 (MP)	4.146E-17 (CP)
BT	11.9177	0.0574	2.47	5.60	1.01088E-19	clay	Tuff				12.936 (SSA)	-	1.3E-19 (CP)
SP7	3.4121	0.0167	2.89	4.13	3.62478E-19	very fine - fine sand	Sandstone	San Pedro	Mid Silurian - Devonian		6.077 (SSA)	1.3E-19 (MP)	4.7E-19 (CP)
LV3	24.0314	0.3385	2.86	1.93	7.61061E-22	fine - medium silt	Pedrosa Limestone	La Vid	Devonian		0.665 (SSA)	3.08E-19 (MP)	9.94E-19 (CP)
CollaD	4.7818	0.0381	2.72	1.78	1.67165E-20	fine sand - granules	Coladilla Limestone				3.827 (SSA)	8.6E-20 (MP)	2.61E-20 (CP)
SLL	2.6110	0.0136	2.71	1.54	3.62351E-20	very fine - medium silt	Limestone	Santa Lucía			3.027 (SSA)	3.78E-20 (MP)	2.696E-20 (CP)
HU7	16.4913	0.1813	2.48	7.84	1.43815E-19	medium - coarse silt	Sandstone	Huergas			7.809 (SSA)	5.5900E-14 (MP)	9.2E-19 (CP)
Portilla	3.2907	0.0300	2.72	0.74	2.50715E-21	coarse silt - very coarse sand (crystallized grains)	Limestone Reef	Portilla			2.584 (SSA)	4.7E-21 (MP)	4.07E-21 (CP)
SE6	19.8770	0.3970	2.48	3.81	1.13846E-20	medium silt - very fine sand	Limestone	San Emiliano	Carboniferous		5.231 (SSA)	7.3E-19 (MP)	1.68E-18 (CP)
Gijón	1.9259	0.0067	2.69	1.60	7.58508E-20	coarse silt - very fine sand	Limestone	Gijón	Jurassic		3.216 (SSA)	1.12E-20 (MP)	2.72E-20 (CP)
Rodiles	24.4699	0.4761	2.68	1.91	8.14404E-22	clay/silt boundary	Limestone	Rodiles			10.979 (SSA)	9.2E-22 (MP)	4.05E-21 (CP)
Vega	1.5429	0.0072	2.34	11.85	6.39929E-17	fine - coarse sand (crystallized grains)	Sandstone	Vega			1.854 (SSA)	5.73E-18 (MP)	3.784E-17 (CP)
VC	2.0897	0.0224	2.46	6.67	5.59626E-18	fine sand - very fine pebbles	Conglomerate				2.184 (SSA)	4.38E-18 (MP)	2.514E-17 (CP)
335	3.0870	0.0207	2.34	-	-	very fine sand - granules (less granules)	Tillite	Guandacol	Carboniferous				
SDA	0.3781	0.0177	1.35	-	-	very fine -medium grains (salt)	Salt	-	-				
PAY	2.8176	0.0370	1.32	-	-	fine silt - fine pebbles	Tuff	-	Early Quaternary				
I62	3.1212	0.0198	0.51	-	-	clay/silt boundary - granules	Tuff	-	Early Quaternary				
TUL TUL	1.9224	0.0133	1.95	-	-	clay/silt boundary - coarse sand	Dacite	-	-				
LN	0.8236	0.0117	1.01	-	-	clay/silt boundary - very coarse sand	Tuff	-	Early Quaternary				
GALAN	2.5592	0.0246	1.32	-	-	fine silt - granules	Tuff	-	Early Quaternary				

MP = measured permeability
CP = calculated permeability