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BGR Bundesanstalt für Geowissenschaften und Rohstoffe

Kaolin

Kaolin deposit Hassi Abyad, Mauritania

Fact Sheet

Introduction

The Hassi Abyad kaolin deposit has been explored by the Federal Institute for Geosciences and Natural Resources (BGR) in collaboration with the Geological Survey of Mauritania "**A**gence **Na**tionale de **R**echerches Géologiques et du **Pa**trimoine **M**inier" ANARPAM (formerly known as OMRG) within the framework of the project "Support for the diversification of the Mauritanian mining sector" between 2016 – 2019. The project is part of the German-Mauritanian development cooperation and was financed by the Federal Ministry for Economic Cooperation and Development (BMZ).

The discovery of the kaolin deposit can be traced back to the well digging of former settlers. The inhabitants of the region prospected for groundwater and dug wells. In each of the wells, they discovered a white rock that can now be identified as kaolin (Figure 1). Due to this characteristic, the place is called Hassi Abyad (white well).

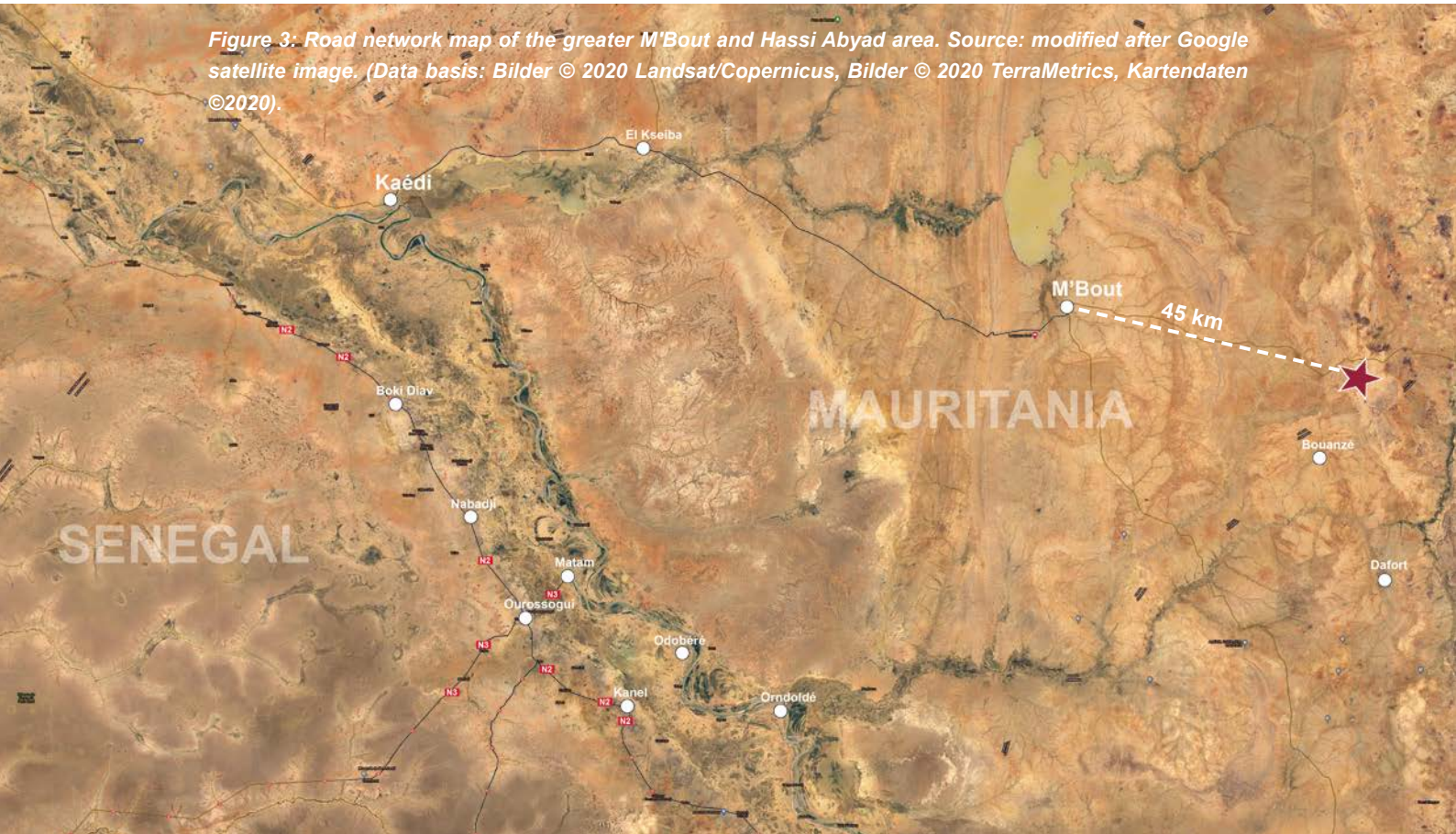
Figure 1: Outcropping kaolin in Hassi Abyad with one of several wells dug for groundwater exploration. Photo: BGR.

Location of Hassi Abyad

The deposit Hassi Abyad is located in the southern part of Mauritania (Figure 2) about 110 km north of the Senegal River and about 45 km east of the village of M'Bout. The roads from larger Mauritanian cities and ports to M'Bout are paved. From there, a gravel road leads to Hassi Abyad (Figure 3).

Figure 2: Location of the kaolin deposit in Mauritania. Source: http://www.omrg.mr/fr/infrastructure.html.

Figure 3: Road network map of the greater M'Bout and Hassi Abyad area. Source: modified after Google satellite image. (Data basis: Bilder © 2020 Landsat/Copernicus, Bilder © 2020 TerraMetrics, Kartendaten ©2020).



Hassi Abyad

The kaolin of Hassi Abyad was formed by weathering of metamorphic rocks of the Late Precambrian Mauritanide Belt (Chaîne des Mauritanides). The metamorphic rocks of this region originate from the metamorphism of volcano-sedimentary sequences. Granitic intrusions are rare in the Mauritanide belt, but occur south of Hassi Abyad. The kaolin deposit either represents an in-situ laterite profile that has been capped by erosion, or is of secondary origin due to the erosion of such a laterite profile and subsequent fluvial or aeolian redeposition of the former primary kaolin. The very fine grain size of the kaolinite crystals and the high purity of the kaolin suggest an aeolian redeposition.

The kaolin deposit Hassi Abyad is located in a gently sloping denudation plain adjacent to outcropping sandstone formations. The overburden of loose sediments is up to one metre thick or completely absent. The kaolin deposit covers at least 5 km².

During the field campaign (2017 – 2019), 150 bore-holes were drilled:

- 145 Auger Drillings: in all-encompassing 1075 m,
- 5 Core Drillings: in all-encompassing 51 m deep.

Main application of Kaolin

- *Clinker and tiles*
- *Sanitary ware and porcelain*
- *Cutting and special ceramics*
- *Fillers and pigments in the paper industry*
- *Carrier of dyes in foods*
- *Shaping material in pharmaceutical industry*
- *Agent for the medical treatment of diarrhoea*
- *Aggregate for the cement industry*

The valuable substance in kaolin is the mineral kaolinite. However, in addition to the kaolinite content, many other factors have an influence on the economic viability of a kaolin occurrence. Generally, many kaolin mines extract kaolin with a kaolinite grade above 30 wt%. Processed kaolin and kaolin sludges are traded with a kaolinite content between 75 and 95 wt%, depending on the application.

The drilling did not completely penetrate the entire kaolin body. A minimum thickness of approximately 30 metres was verified in one borehole (Figure 4). Fine-grained, greasy material was found below 30 metres. This material is soft and includes quartz, kaolinite, orthoclase, plagioclase and muscovite, among others. While the auger drillings were sampled in an interval of one metre, the drill cores were sampled according to their lithology. All samples were examined with respect to their geochemical and mineralogical composition in the BGR laboratories.

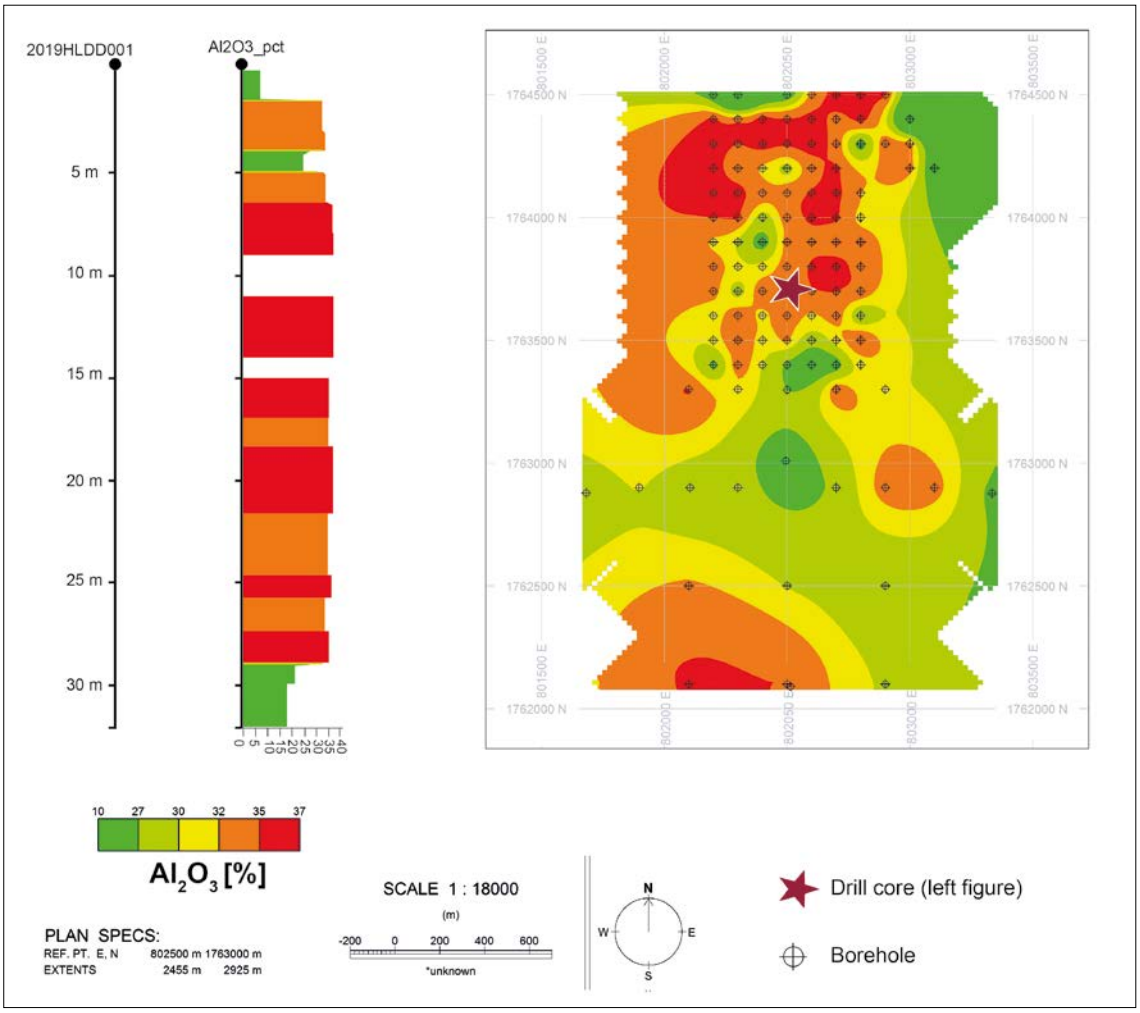


Figure 4: The figure on the left shows the Al_2O_3 concentrations along a drill core. The Al_2O_3 concentrations of the investigated deposit averaged over the entire depth are illustrated in the figure on the right. Source: BGR.

Composition of Kaolin

Mean major element concentrations (based on 613 samples)

SiO_2	Al_2O_3	Fe_2O_3	TiO_2
48,98 wt%	31,73 wt%	3,75 wt%	1,84 wt%

The average Al_2O_3 content of the kaolin from Hassi Abyad is 31.73 wt% (n = 613). Since no other clay minerals and no other Al-containing minerals were detected, it is possible to infer the kaolinite content directly from the Al_2O_3 content. An average Al_2O_3 content of 31.73 wt% corresponds to an average kaolinite content of approximately. 85 wt%. This calculated kaolinite content was confirmed by mineralogical investigations on 37 random samples by means of X-ray diffraction. Quantitative X-ray diffraction of these samples yields a kaolinite mean value of 86.5 wt%.

Based on the geochemical analyses, a 3D model of the kaolin deposit was developed. The 3D model was created from all drill samples using the Geosoft Target® software (Figure 5). The interpolated mean value of Al_2O_3 is 29.74 wt%. This corresponds to a kaolinite value of about 82 wt%. Comparing the percentage of kaolinite in other mines, Hassi Abyad therefore represents a very pure kaolin deposit. The calculated volume of the deposit contains about 30 million m³, although the outer limits of the

deposit are not known yet. However, it can be assumed that the deposit extends laterally, especially to the north and the east. In general, a tonnage of 80 million tons of kaolin is estimated for Hassi Abyad, including 65 million tons of kaolinite. These estimations are based on the calculated volume, an average density of ρ = 2.65 t/m³ and the interpolated mean kaolinite content.

Kaolin properties and applicability

The Hassi Abyad kaolin is very fine grained with more than 70 % in the grain-size fraction smaller than 2 µm. Ceramic suitability tests of selected (low-iron) samples shows that the kaolin is principally suitable for the manufacture of various ceramic products (sanitary and table ware, wall and floor tiles, technical porcelain) and possibly as a refractory material. However, the kaolin is characterised by high total shrinkage, which is typical for kaolinite-rich materials. The application as a filler and/or pigment has not been investigated yet. Due to the somewhat elevated iron (Ø 3.75 wt%) and titanium (Ø 1.84 wt%) contents in large parts of the deposit, further processing steps are necessary for some applications. Elutriation and wet screening tests of such material also reveals low rates of suspension in water and a high thixotropy.

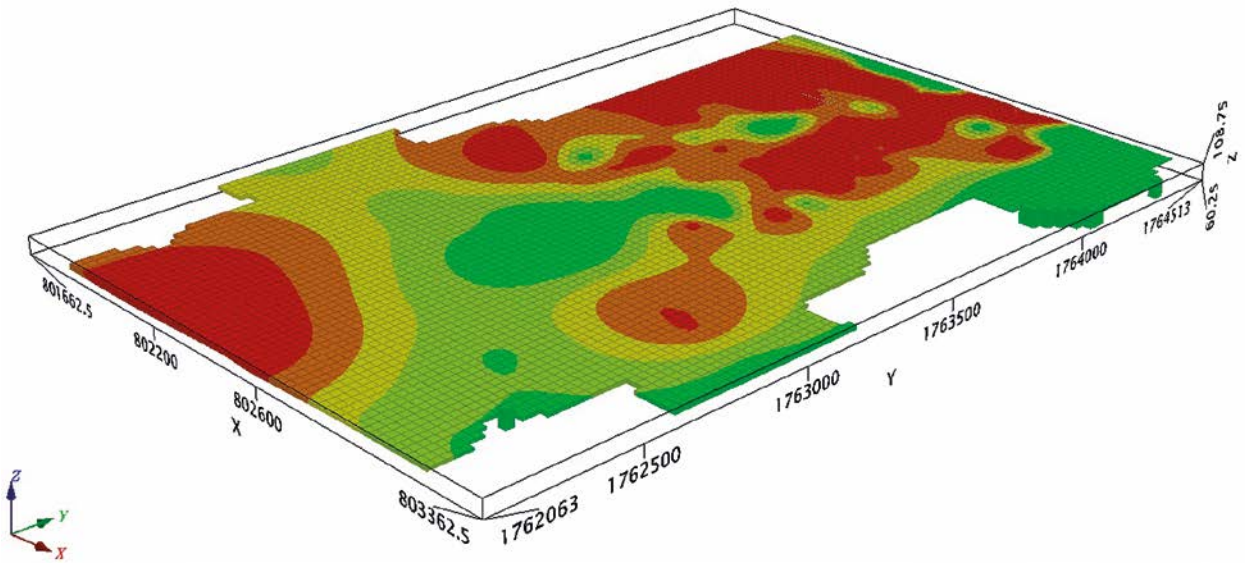


Figure 5: 3D Voxel model of Hassi Abyad. For each metre of drilling a representative voxel block is created reflecting the specific geochemical properties. In order to model zones for which no geochemical data exist (e.g. between two boreholes), the software interpolates based on the deposit model. Source: BGR.

Figure 6: Auger drilling in the kaolin. Photo: BGR.

Commercial mining and processing possibilities

The processing techniques of kaolin depend on many factors and must be chosen based on individual requirements. The mineralogy, trace element content and the requested final product determines whether a wet or dry processing is necessary (Figure 7).

A wet processing can be used to treat all types of kaolin. To produce a pure, clean and white kaolin at least hydrocyclones are essential. Optional flotation cells and/ or magnetic separators can refine the final product if, for example, impurities such as iron and titanium need to be removed. After thickening and drying the kaolin, the product can be traded globally or locally, depending on the quality.

The alternative to treat kaolin is the dry processing method. It is a more economical option and ideal for dry climates. After grinding the run of mine material (ROM), it undergoes air flotation or jigging machines. There, the heavy and light fractions are separated as long as the kaolin components to be separated have a sufficiently high difference in density. If necessary, magnetic separation might be beneficial as well. However, the dry processing of clays is not very selective. It is therefore recommended for deposits with a low contamination and for clays with a high thixotropy.

To extract the kaolin in Hassi Abyad, quite simple methods and techniques can be used. Kaolin mines with similar parameters are use a standard cut-and-fill mining process. In Hassi Abyad, extraction by shovel and truck is recommended. Because of the thin overburden (max. one metre), the strip ratio is less than one (sr < 1). This enables the quick development of a mining operation.

The Hassi Abyad deposit is located in the populous south of Mauritania, which is favourable for creating additional value chains and markets. The deposit itself is located in a rural area with small settlements, where no large areas are used for agricultural purposes. A lake is located north of M'Bout and its water may be considered for kaolin processing.

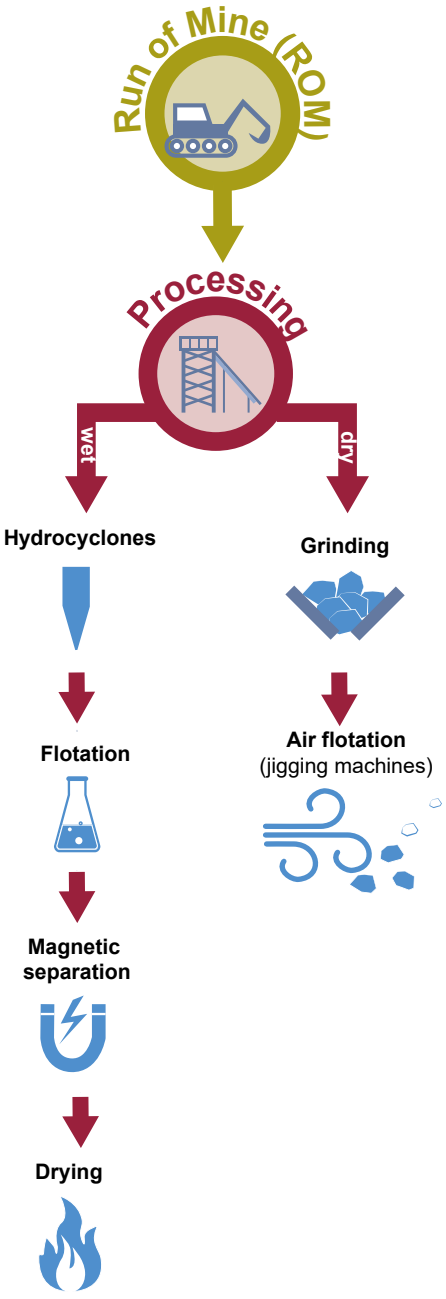


Figure 7: Possible processing steps of the kaolin using a wet or a dry process. Source: BGR.

Figure 8: Outcropping kaolin in a wadi overlain by unconsolidated sediments with a thickness of up to one metre. Photo: BGR.

Imprint

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Cover photo: Outcropping kaolin in a wadi. Photo: BGR.

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