

Mineral Raw Materials at Amberger Kaolinwerke

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Deposit conditions, product characterization and quality assurance

Introduction

The raw materials for the ceramic-grade kaolins supplied by **Amberger Kaolinwerke's** (AKW) kaolin plants are extracted in part from the deposit at Hirschau-Schnaittenbach (Upper Palatinate/D) and in part from the deposits at Groeppendorf and Schleben/Crellenhain (Saxony/D). Processing is carried out at the plants at Hirschau-Schnaittenbach and Kemmlitz.

Ceramic-Grade Kaolins from Hirschau-Schnaittenbach

The genesis of the deposit at Hirschau-Schnaittenbach began ca. 240 million years ago (New Red Sandstone, Lower Triassic). At this time the depression found here was filled with the erosion debris from the southern and southeastern highlands consisting of granites and gneisses. Acidic waters subsequently decomposed the feldspar and mica components to form kaolin. During the formation of the Alps the sedimentary layers were shifted. In Schnaittenbach, they occur with a 5...8° inclination to the north. At the open-pit mining operations at Schnaittenbach, ca. 800 000 tonnes of rock ("crude ore") is won annually using excavators and transported via conveyors to the stockpile area. The kaolin content in the rock is between 11 % and 14 %, and the feldspar content is 5 % to 10 %. The rock mass is primarily made up of quartz (ca. 80 %). The most important quality parameters are viscosity, chemical composition, and whiteness of the kaolin fraction. The grade distribution of the deposit is already determined before it is opened up via core sampling and analysis. To balance out fluctuations in grade within the deposit, mining is done selectively. In open-pit mining operations, mining is controlled via analysis results from rock samples taken from the working face. In this way, qualitatively varying stockpiles are formed. This piling process is



Fig. 1 Amberger Kaolinwerke: Suspension of valuable crude ore in water in first coarse separation stage for mineral components kaolin, feldspar, and quartz sand

monitored: An automatic sampler takes samples from the conveyor belt at specific time intervals. At the end of the piling process, the samples are analyzed. Pile removal and transfer to the production lines is controlled via the analysis values. For the two complete processing lines at the dual location Hirschau-Schnaittenbach, production control is performed using ceramic parameters. This ensures that the required ceramic properties of the kaolins remain constant.

The processed kaolins Kick 1 and Kick 2, as well as Kick 22, based on the crude ores especially from the Schnaittenbach open-pit mine (Kick 2 and Kick 22 differ only minimally in terms of quality parameters, but they are produced on two different processing lines due to capacity limitations) are offered by AKW preferentially for use in the sanitary ware industry. Whereas the quality of Kick 1 allows it to be viewed as a universal kaolin in this area, Kick 2 (Kick 22), as a very coarse product, offers the user the possibility of significantly improving cast-layer formation in the casting slips. With this product, AKW has a raw material that can be offered with comparably constant properties by only a few

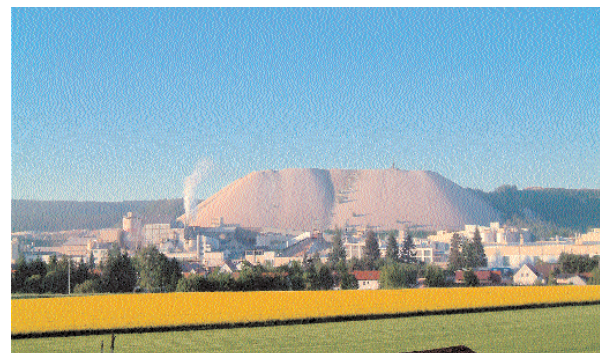


Fig. 2 In foreground, view of the Hirschau plant from the north; behind it, the region's symbol, Monte Kaolino



Fig. 3 (left) During the piling process the valuable mineral crude ores are homogenized

other suppliers. Over the last few years numerous investments were made to modernize the technologies used to guarantee the present and future stability of these two products despite the not-completely-optimum deposit conditions. However, to prepare in the medium and long terms especially for the ever-stricter requirements of the market and to enable the company to remain ahead of the competition from Eastern Europe, additional, foresighted changes are necessary. For this reason, among others, AKW has decided to use the high-quality raw material reserves found at the Schnaittenbach plant for production of ceramic-grade kaolins of the previously mentioned qualities. In connection with this decision is another large investment, which foresees the phase-out of the Schnaittenbach plant by 2015 and concentration of production at a plant location that is operating profitably with modern production facilities. This investment programme is oriented toward the future to secure the company's position in the ceramic market over a longer term.

Ceramic-Grade Kaolins From Kemmlitz

The Kemmlitz kaolin district represents the region in Germany with the most important whiteware grade kaolins. This is justified by a

series of specific properties that make these kaolins particularly applicable for various porcelains and other whiteware products. The kaolins contain as valuable minerals not only kaolinite but also illite-montmorillonite mixed-layer minerals, endowing the kaolin with a favorable formability and high dry bending strength and thus favorably affecting the workability properties of plastic bodies. To improve the workability of the kaolins in casting slips, in contrast, the low viscosity of specific kaolin types is decisive; through appropriate contents of organic substances, it can be improved even further. The content of colourant Fe and Ti compounds is extremely low, at $< 0,6\%$, for which reason the kaolins fired at 1410°C have very high whiteness grades. Taken as a whole, these properties explain why the Kemmlitz kaolins count as the main components of whiteware bodies. Since the end of the 19th century these raw materials have strongly shaped the technology of porcelain manufacturing and the quality of German porcelain. In the region around Kemmlitz, the existing volcanites of the lower Permian display varying degrees of kaolinitic weathering over an area of ca. 40 km^2 . Within this area, places where the weathering crust reaches a thickness of 70 m alternate with places in which kaolins are completely missing or are only a few

meters thick. Apart from the primary host rock, which is kaolinized to varying depths, tectonic movements as well as Pleistocene erosion processes played a major role in determining the degree to which the weathering crust was preserved. In the Kemmlitz district, ten different deposits have been exploited profitably since 1840. These deposits were found in part in a southern area, essentially between Kemmlitz, Neusornzig, Boertewitz, and Querbitzsch. Only in recent times (starting in 1964) was a northern kaolin occurrence found between Groeppendorf, Glossen, Schleben and Muegeln-Crellenhain and later developed. These two subareas are separated by the Doellnitz dorr, an element of Late Pleistocene erosion and sedimentation.

Mining of kaolin from the northern kaolin area commenced in 1972 at the Groeppendorf open-pit mine. For processing of the raw kaolin, slurring facilities were built on the west side of the mine. Supply lines were laid from these facilities to Kemmlitz, ca. 3 km away, where further processing is performed. Both the processing facilities and the lines to Kemmlitz were modernized over the last few years.

Schleben/Crellenhain Deposit

Geology of the Deposit

The source rock for the kaolin is Kemmlitz porphyry, as in the Groeppendorf deposit. The Schleben/Crellenhain deposit forms a horseshoe around the Kreuzgrund nature reserve, where porphyry occurs under a thin Holocene layer. In the Kreuzgrund region and in the so-called Pfarrscheune region, small porphyry quarries existed earlier, as the geological map, sheet Oschatz/Muegeln shows (Siegert 1906). In the region where the deposit occurs, five kaolin basins of depths $> 30\text{ m}$ were proven to exist. Between the individual basins are porphyry swells (Nebitzschen, Kreuzgrund, and Pfarrscheunen swells) that are not as kaolinized or completely lacking in minable kaolin formations (Siedler swell between the Crellenhain West and Schleben three basins). The deposit borders are formed by porphyry crests; in the northwestern and northeastern regions, the increased thickness of the overlying rock ($> 30\text{ m}$) represents an economic feasibility limit for potential

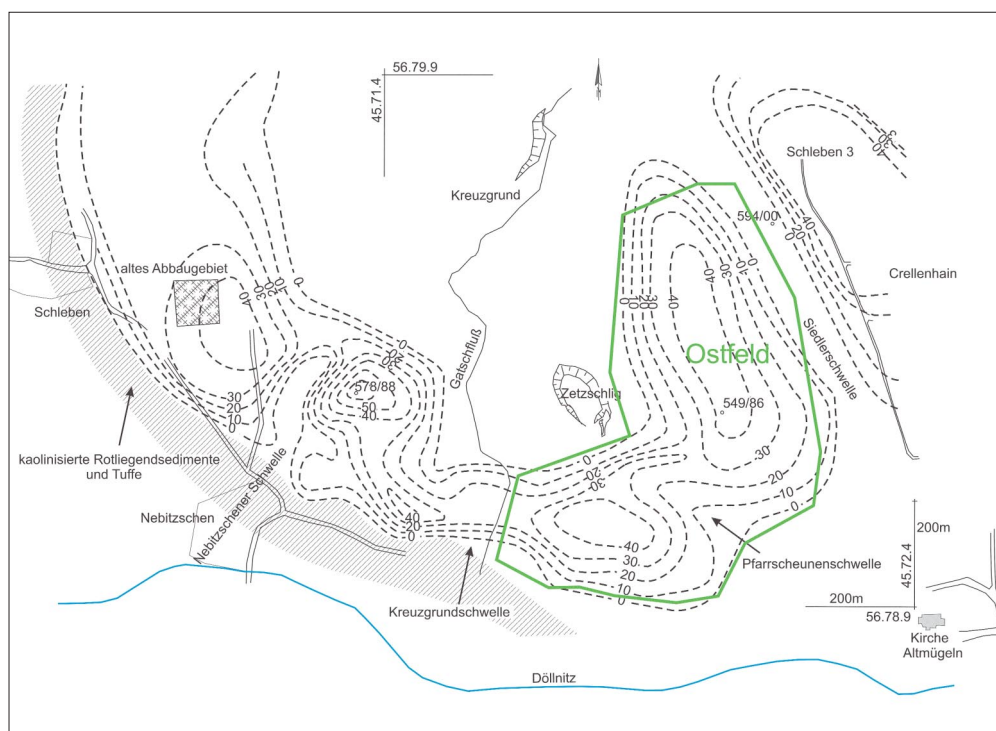


Fig. 4 Schleben/Crellenhain deposit

mining. In the southwestern and western regions, kaolinized sediments of the lower Permian form the border of the deposit.

The overlying rock consists mainly of Pleistocene sediments. Under a Holocene topsoil of average thickness 0,4 m are local regions of meadow- or slope loam (1...5,4 m), especially in the Doellnitz area and on the slopes of the Gatsch river valley. The primary sediment is Weichsel Glacial loess loam (1...11 m). Till loams only occur as relics, with kaolin partially worked into the till loam (probably Elster Glacial). On the kaolin surface is a terrace formation with gravel and rubble (0,2...2,8 m) in the south, representing a branch of the Doellnitz dorr found in the southern part of the deposit.

Mineral Content of the Deposit

In terms of its composition, the kaolin is comparable to the Groeppendorf deposit. Light brown to brown colour tones are prevalent. The brown colour can be attributed to organic components. The porphy structure is easily recognizable. It is lean to fat, but raw kaolins with average clay substance contents are prevalent. Comparison of the core and analysis results with the Groeppendorf deposit currently being mined do not reveal any basic differences, and hence it can be concluded that kaolin slurries that are comparable with those of the Groeppendorf deposit can be produced from the eastern field of the Schleben/Crellenhain deposit.

Since the end of 2004 the raw kaolin from the open-pit mine at Schleben/Crellenhain, Eastern Field (S/C, EF) has been a component of products from the Kemmlitz kaolin plant. The raw kaolin part from the Groeppendorf open-pit mine that is currently used is appr. 40 % to 60%. Especially in terms of rheological properties, a positive development can be seen. With improvement of the viscosity, universal application possibilities result because the valued advantages such as good plasticity in connection with a very white fired colour are simultaneously retained.

Mining of the Deposit

The deposit is crossed by two roads in the west (from Nebitzschen to Schleben and to Seelitz); additionally, a part of the reserves is blocked by construction. For this reason, mining was commenced in the eastern region of the deposit. For mining of the Schleben/Crellenhain deposit, a 3-km-long cross-country conveyor system was erected between the deposit and the processing facilities at the Groeppendorf open-pit mine for waste and kaolin, and the first pieces of mining equipment were driven to the new open-pit mine. Opening up of the deposit in the eastern field was begun in February 2004. After the adit was completed, conveyor belts were set up in the open-pit mine for transporting the waste in the dump and the kaolin in the stockpile to the slurring facilities in Groeppendorf. Normal overburden operations via the conveyor belts began in August 2004 and kaolin operations began in November 2004. Up to the end of 2006 the raw kaolin from the Groeppendorf and Schleben/Crellenhain, Eastern Field open-pit mines will be extracted in parallel, after which time the main field of the Groeppendorf open-pit mine will be depleted of clay, and at the S/C, EF open-pit mine, kaolin of varying quality will be made available in multiple stages to optimize grades mined.

The range of whiteware-grade kaolins MEKA, BZ, and OKA supplied over the past decades has been supplemented by the ARCANO series in the last few years. The requirements arising from the dominant technologies, such as isostatic pressing and pressure casting, used in the tableware industry, were met in special ways. It was likewise attempted to supply tailored products for the various body types (hard porcelain, vitreous china, and bone china). Use of valuable minerals from AKW brought with it significant advantages in the production processes of more than a few tableware producers worldwide as well as excellent results in terms of end product quality. Thus, e.g., with ARCANO DGK, the cast-layer formation rate can be



increased, or with ARCANO HBF, the plasticity of plastic masses can be improved. For production of spray granules, ARCANO STA in particular and, in special cases, also ARCANO HBF extend the application possibilities.

The very white fired colour of the Kemmlitz kaolins produces especially visible improvements in whiteware end products. This property, which can be attributed to the raw material, in connection with the product diversification measures already mentioned enable nearly universal application in the global tableware industry.

References

- [1] from the mining monograph "Kaolin Kemmlitz" by G. SCHWERDTNER, H. ANGER, M. STÖRR, Publisher: Free State of Saxony, Saxony State Office for Environment and Geology (year of publication: 2006)

Fig. 5 (top)
The new Schleben/Crellenhain open-pit mine in January 2006

Fig. 6 (bottom)
A bucket-wheel excavator during excavation of crude ore