DEPOSITS OF CERAMIC RAW MATERIALS: EVALUATION AND PLANNING OF SUSTAINABLE MINING

Espina, R.G.[1], López-Corzo C.[1], Santiago J.C.[1] and Sanfeliu, T.[2],

[1] Technical Department of Watts Blake Bearne España (C/Ruiz Zorrilla nº1 6ªPta., 12001 Castellón).
[2] Unit for Applied and Environmental Mineralogy. Dept. of Experimental Sciences, Universitat Jaume I, Castellón de la Plana.

ABSTRACT

The present poster outlines the methodology used in the mining evaluation and planning of several industrial mineral deposits, essentially marketed for the ceramic industry. The raw materials mined in these deposits are red clays in the provinces of Castellón, Valencia and Teruel, and siliceous sands, feldspathic sands and kaolin in the province of Valencia. Based on the geological models developed with a mining "software", an exact evaluation is made of the deposit in terms of reserves and quality distributions, in addition to programming the mining operations until the mine runs out, taking into account the environmental sustainability of the mining work.

1. WORK METHODOLOGY USED

The deposits are modelled by means of a software programme (GEMCOM) that processes geochemical and geological data to which the desired mining parameters are applied. The information relative to the test drillings (borehole co-ordinates, direction, length, crossed lithologies, and sample analysis) is entered into the programme, together with the digitized topographic surface, for subsequent visualization and analysis. The in-depth interpretation is made in a series of vertical cross sections that encompass the entire surface of interest. 3D modelling of the mineralized bodies is then performed, based on the 2D interpretation. These mineralized bodies are geostatistically assigned the quality parameters of greatest interest, depending on the type of mineral. This yields the quality distributions of the parameters sought by the clients, such as linear shrinkage, water absorption, plasticity, reject or carbonate content for red clays, or the silica, alumina, iron, titanium, lime, potassium content, etc., for the other ceramic materials (silica sand, feldspathic sand and kaolin).

When the geological model and the quality distributions have been obtained, the existing reserves and resources are calculated by designing an optimum cut, which assures thorough use of the deposit. Finally, a planning is made (annual, monthly, etc.) of the final cut, whose useful life will be determined by the rate of extraction, market demand and quality requirements.

2. EXAMPLES OF CERTAIN DEPOSITS

The poster sets out different examples of mineral deposits relating to the ceramic industry of the Valencia Region. These examples include photographs that bear witness to their geological complexity, tables of reserves, industrial applications of the minerals mined, three-dimensional models developed and the foreseen mine designs until each operation's life cycle ends.

2.1. RED CLAY MINE OF MORÓ

The San Juan de Moró (Castellón) mine currently produces 2.3 Mt a year, which represents 22% of the red clays consumed by the ceramic industry in the Valencia Region. From a strictly mining point of view, two main groups can be differentiated, the minable clay package of Moró and the different types of overburden on top of the package, generally by normal faults, which represent the main control in the spatial distribution of the Moró clay package. This network of faults controls both the thickness of the minable layer and the volume of overburden on top. The poster displays a cross section and a three-dimensional geological model of the Moró mine, in which the various geological units are distinguished. The final pit is also foreseen for definitive mining advance and the final volume of reserves.

2.2. RED CLAY MINE OF GALVE

The Galve (Teruel) deposit occupies the core of a wide synclinal trough filled during the lower Cretaceous by alluvial channel (feldspathic sands) and flood plain (red clays) deposits. The mine presently in production extracts

500,000 t/year of red clays, occupying a minimum surface area of this trough, in which the mining resources are very high. The clay levels have a very homogeneous quality, which is highly valued in the ceramic sector, since their use greatly reduces the existence of calibers owing to their high bulk density (compactness) values and the presence of a large percentage of kaolinite, which provides the ceramic body formulations that contain this type of clay with dimensional stability.

2.3. RED CLAY AND FELDSPATHIC SAND MINE OF MADROÑO

At the Madroño (Valencia) mine, a sand-clay package is operated pertaining to the Albian Age, with an annual production of 1,100,000 t in clays and sands. The Madroño deposit is tectonically quite complicated, with multiple normal faults of different direction and dip, which interfere with each other. The different layers are represented in the geological model, where they are assigned a quality according to the data obtained from the test drillings, as well as the geological accidents of greater mining influence. The Madroño clays belong to the type of clay known as Villar clay by the ceramic sector, which forms the main plastic component of red ceramic body formulations (30-60%).

2.4. KAOLINITIC SAND AND RED CLAY MINE OF YESA

The Yesa (Valencia) mine produces 550,000 tons of clays and sands annually. This deposit consists of 6 layers of kaolinitic or kaolinic-feldspathic sands separated by Albian Age levels of red clay, laid out in a north south direction and structured in a gentle syncline in the same direction. Each of the kaolinitic sand layers has its own characteristics with regard to kaolin content, composition and quality (the same can be said of the siliceous sands), while the red clays are also worked separately for the Castellón stoneware tile market. The kaolinitic sands are transported in their bulk to the treatment plant at Higueruelas (Valencia), where the sand fraction is separated from the kaolinitic fraction by desilting and hydrocycloning. The kaolin is of two qualities; a superior or A kaolin, which has 36% alumina, and a lower quality or B kaolin with 33% Al_2O_3. Both kaolins are fundamentally marketed for the manufacture of white ceramic bodies. The silica sand is used in the high quality flat glass market. With regard to the ceramic clay piles that are sold, these are made individually according to each clay level, due to the existing differences in ceramic behaviour. There are slightly refractory kaolinitic clays, which alternate with very fluxing illitic clays, and even very refractory quartzose clays. The Yesa clays are used by clients as correcting constituents in their formulas, which is why the type of clay and percentage of use vary considerably.

3. ENVIRONMENTAL RECOVERY

Making clearings and embankments produces strong alterations in the relief, with the creation of artificial banks that did not exist before. Although mining planning does its utmost to minimize the existence of outside tips by dumping in the pit itself, there are old tips dating back to the first years of the operation. There are therefore three basic pillars on which the environmental recovery of a mining operation needs to be based:

1) Making maximum use of the pit produced by the mining operation as an area for dumping overburden. This requires drawing up a sequential planning of the operation from start to end.

2) Restoration by installing earth walls and replanting already existing tips.

3) Replanting the berms when the final mining operation bank has been reached.

4. CONCLUSION

Proper planning of a deposit leads to a rationalized mining operation, which in turn allows performing the pertinent environmental actions, consolidating sustainable mining development, which is essential for the ceramic industry.