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Note

Genesis and mining potential of kaolin deposits in Patagonia (Argentina)

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ABSTRACT

Kaolin occurs in Patagonia as residual (weathering or hydrothermal) deposits at the surface of an extended Jurassic rhyolite province or in the upper sedimentary Cretaceous or Danian–Paleocene layers. On the same paleogeographic surface, numerous epithermal Au–Ag lodes occur, making kaolin genesis a crucial point in mining exploration. The weathering or sedimentary genesis of some deposits (Puma, Súper, FPS, Espingarda and Marta) was confirmed through clay isotope results. The origin of some corrective clays (Bajo Grande and White Bentonite) was analyzed and compared with that of one sample from Ukraine and one from a hydrothermal deposit in Furtei, Sardinia, Italy. In Patagonia, the residual and sedimentary kaolin deposits have resources of over 12 million tons. The identified hydrothermal deposits have more limited resources, due to their strong mineralogical zonation, which requires their selective "pocket" kaolin exploitation. The Patagonian region is the southernmost part of a continent where a Gondwana paleosurface of Late Mesozoic age developed on Jurassic rhyolite volcanic units. This surface is exposed along tens of thousands square kilometers in the cratonic units of northern and southern Patagonia, having a strong potential for finding new kaolin or epithermal precious metal deposits.

1. Introduction

The Patagonian residual kaolin deposits occur over a paleosurface of an extended Jurassic rhyolite province named Bahía Laura Group (Lesta and Ferello, 1972), or Marifil Formation (Malvicini and Llambías, 1974) outcropping in two cratonic areas: Macizo del Deseado and Somuncura. The sedimentary ball clays, derived from kaolinized volcanic parent rocks, occur in the Cretacic Baquero Formation (Archangelsky, 1967); or in the Danian–Paleocene Salamanca Formation (Lesta and Ferello, 1972).

Even today a controversy exists about the origin and significance of these kaolin deposits. After a pioneering isotopic work, Murray and Jansend (1984) found that several kaolin deposits were residual, and afterwards many studies confirmed that kaolinite was formed by weathering in a warm climate along the Late Jurassic time (Cravero et al., 1991; Cravero et al., 2001). On the same paleosurface, many epithermal precious metal deposits with hydrothermal kaolinite alteration have been discovered and in some cases, kaolin has been exploited (Fig. 1). In the Río Negro Province, the kaolin hydrothermal genesis has been confirmed (Blanquita, Equivocada; Marfil et al., 2005) and in the same area, other kaolin manifestations were linked to a high sulfidation system (C° La Mina; Ducart et al., 2006).

The relationship between kaolinite deposit genesis and potential resources is not easily found in the literature. Only the USGS Deposit Models, with frequency tonnage figures, can be used for estimating the potential resources for residual, hydrothermal or sedimentary deposits (Hosterman and Orris, 2000; Hosterman, 2000).

The purpose of this study was to confirm, by stable isotopes data, the weathering-sedimentary kaolin genesis of some of the major Patagonian kaolin deposits used due to their ceramic properties (Dondi et al., 2008; Zanelli et al., 2011). The local industry needs around 300,000 t per year. Other corrective clays and one of clearly hydrothermal genesis were studied for comparison. An additional purpose of this work was to establish the relationship between kaolin genesis and the potential deposit resources. The early field estimation of a weathering or hydrothermal genesis is significant in terms of exploration strategies.

2. Geology of deposits

The residual (weathering or hydrothermal) sedimentary kaolin deposits are found in a wide variety of Jurassic volcanic rocks and their overlapping sedimentary Cretaceous or Paleocene layers are in an area of more than 500,000 km^2 in more than 200 mines in the Santa Cruz, Chubut and Río Negro provinces (Fig. 1).

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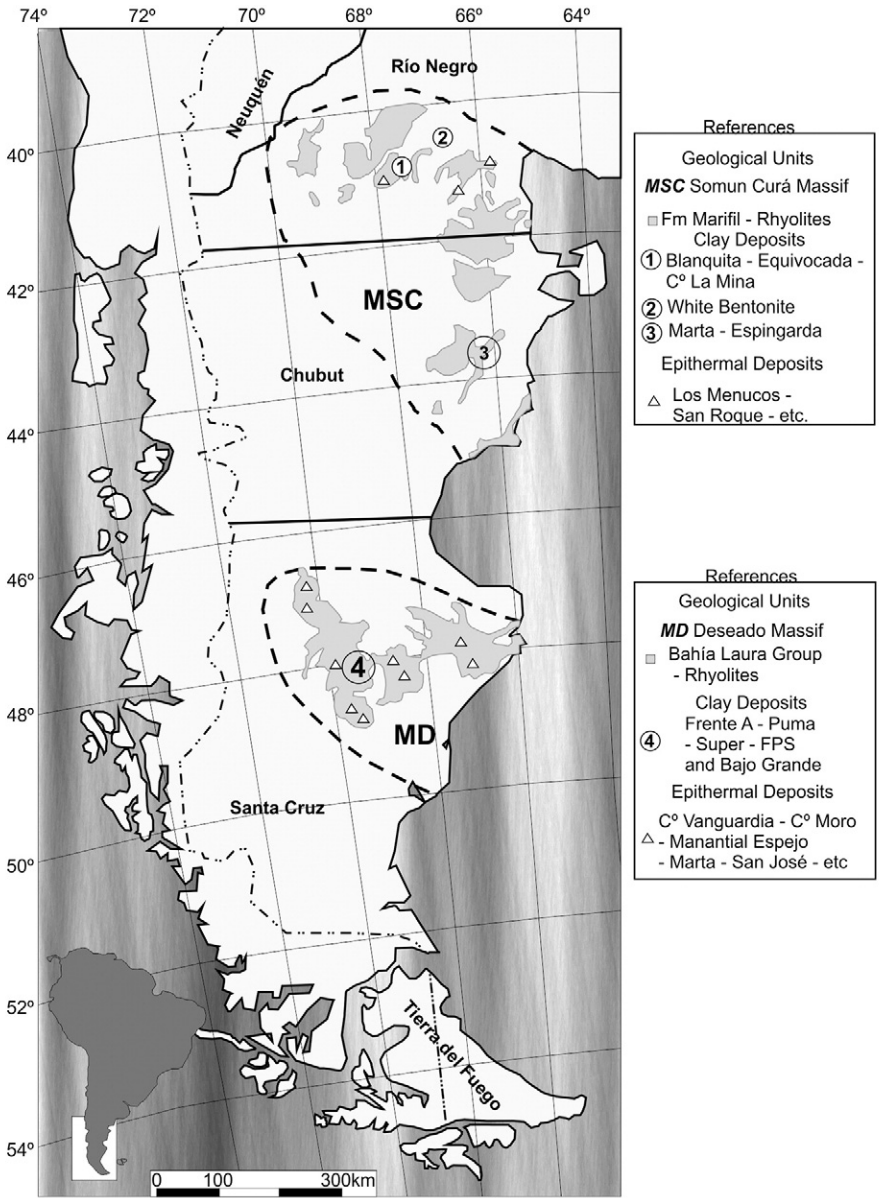

Fig. 1. Distribution of kaolin and epithermal deposits in the Patagonian Gondwana rhyolitic paleosurface.
Map modified from Fernández et al. (2008).

The geology, mineralogy, and kaolin properties of the major deposits Frente A, Súper, FPS, Espingarda, Marta, and Bajo Grande were described in detail by Domínguez et al. (2008 and 2010) and Dondi et al. (2008). The White Bentonite corrective clay deposit is located in a sedimentary layer belonging to the Neuquén Group (Cretaceous) in the Río Negro province. Bentonite forms extended lens up to 2.5 m thick between sands, silts, and tuffs. Mineralogically, the material is composed of montmorillonite, and opal-CT, although small amounts of volcanic fragments, glass shards, quartz, albite, and biotite are also present (Vallés and Impiccini (2003)). The Ukrainian clay comes from the Miocene sedimentary deposits of the Donetsk basin (O'Driscoll, 1998) and it consists mainly of poorly ordered kaolinite, interstratified illite/smectite and a low quartz content (Zanelli et al., 2015). The hydrothermal kaolin comes from the gold deposit of Furtei, Sardinia, Italy. The exploited kaolin forms a tabular body 15 m in thickness developed in a volcanic sequence. Currently, it is not industrially used, and details of its geology and mineralogy can be found in Ruggieri et al. (1996) and Simeone et al. (2005).

3. Materials and methods

Samples of sedimentary (Puma, Frente A, Súper), residual (Espingarda, Marta) kaolin deposits along with high plasticity corrective clays were analyzed (Bajo Grande, White Bentonite). One sample from Ukraine (sedimentary) and one from Furtei, Sardinia (hydrothermal) were used for comparison. The samples were taken by a combination of channel and chip methods at the working fronts.

For isotopic determinations, the <2 μm fraction was concentrated by centrifugation and its purity was controlled by X-ray diffraction and the water released during the hydrogen extraction. The sample purity is as follows: In Frente A the kaolinite content is over 96% with 4% quartz; in Espingarda, Super, and Puma is over 99%; in Furtei is over 98% with 2% quartz; in Marta is over 90% with 9% interstratified (Ie) I/Sm clays and 1% quartz; in Ukrania is over 74% with 23% Ie–I/Sm and 3% quartz; in FPS is over 32% with 68% Sm; and in Bajo Grande and Bentonita Blanca the smectite content is over 98% with 2% kaolinite.