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GEOCHEMISTRY OF THE MAFIC-ULTRAMAFIC BODIES OF THE SIERRAS DE SAN LUIS, ARGENTINIA

by

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The Sierras de San Luis, an uplifted mountain block of high grade metamorphic rocks located in the Sierras Pampeanas, Central-Argentina is one of many isolated mountain blocks surrounded by sediment filled basins that characterize the Sierras Pampeanas. The observed structures are related to the Tertiary Andean orogeny, where the different mountain ranges were uplifted by reverse faulting and local folding during late Cenozoic times (JORDAN et al., 1983).
The Sierras de San Luis are made up of a metasedimentary crystalline basement which was intruded by a variety of magma types in several stages. Pre- or syntectonic granitic intrusions, syntectonic mafic-ultramafic intrusions and posttectonic granitic intrusions form the main mass of intrusive rocks in the basement. In the field the mafic-ultramafic intrusion is observed in the form of many lense-like outcrops intercalated in the basement. The lenses are found mainly in a 10 to 20 kilometer wide corridor stretching from east to west at La Trapiche and about 100 kilometer in length following the main strike of the area (Fig. 1). Typically the size of the bodies is between 500 meter to 5 kilometer in length and up to several hundred meter in width. In some areas metapelitic rocks may contain small mafic lenses with diameters of several decimeters. Mineralogically and geochemically they behave like the large bodies. Ultramafic parts of the gabbro complex, cumulates, are usually not observed at the surface, but have been found in several drill cores of the Las Aguilas mafic-ultramafic body. They consist of slightly serpentenized olivine, pyroxene, Cr-spinel, and sulfide rich rocks. The massive gabbro consists of amphibole, orthopyroxene, plagioclase, and clinopyroxene. Igneous features such as compositional banding and coarse to fine grained layers are not common. The rocks are usually very fresh and fine to medium grained. Locally, amphiboles may become coarse grained with crystals of a few centimeters.
Geophysical investigations have confirmed that underneath the surface these lenses are part of a large intrusive complex (BJERG et al., 1997). The intrusion is mainly gabbroic in composition and was intruded in a regional amphibolite facies crystalline basement in a middle to lower crustal position. The depth of intrusion is estimated to be about 15 to 21 km (5 - 7 kbar) based on geobarometry of the surrounding metapelites. Geothermometry of the basement rocks yields temperatures of 540°C to 630°C and locally 750°C to 800°C in areas close to the contacts of the gabbroic complex.

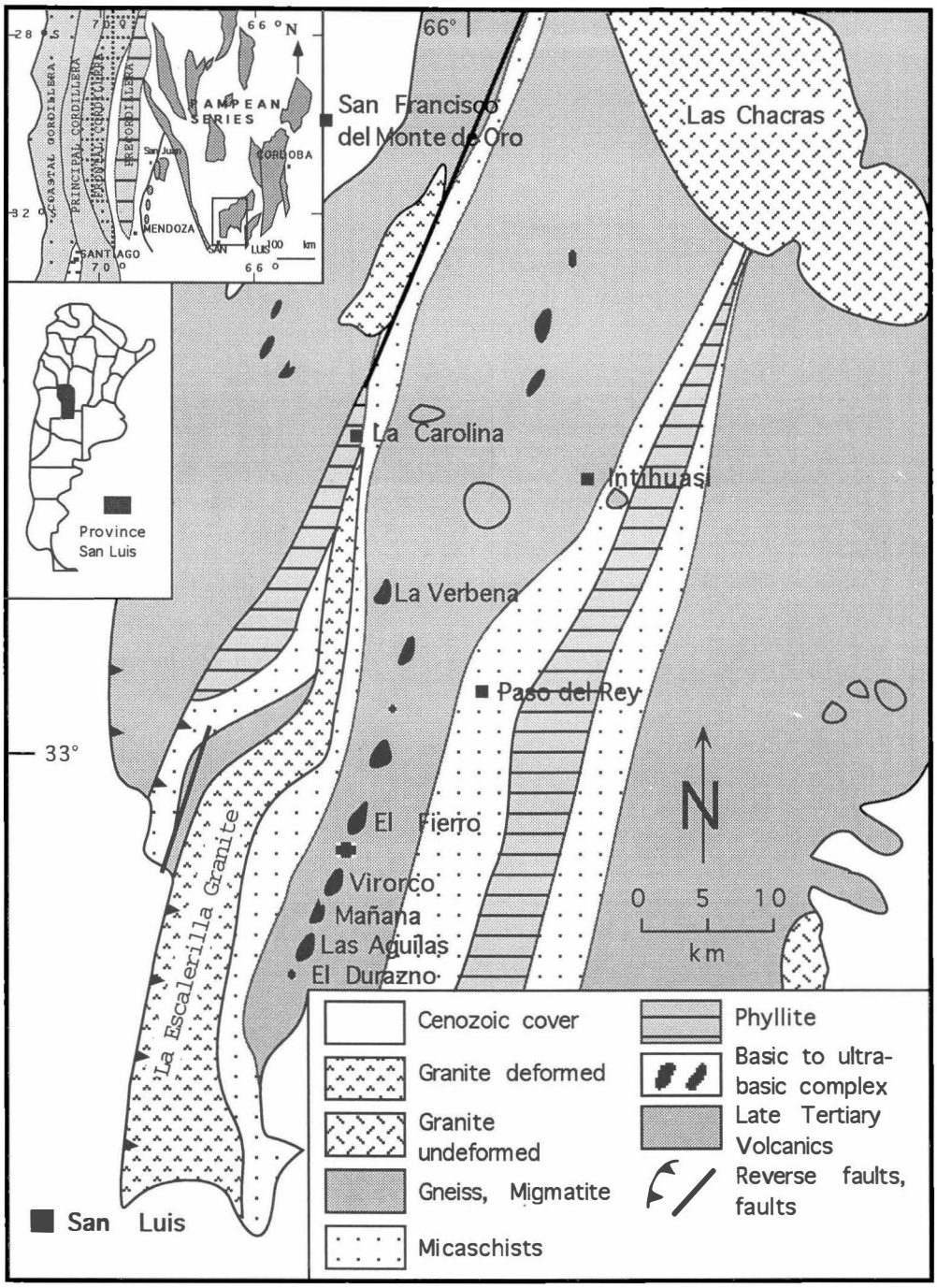

Fig. 1
Simplified tectonic map of the Sierras de San Luis with the location of the larger mafic-ultramafic bodies

The variation in SiO_2 is small in gabbroic rocks ranging from about 45 to 55 wt.%, only cumulates show a spread of about 20 to 50 wt.% SiO_2. The FeO content is about 5 to 15 wt.% in gabbroic samples and 10 to 30 wt.% in cumulates. The variation of FeO with MgO is relatively small, only the amount of sulfide content enriches the samples significantly in Fe, independently from the MgO values. Al_2O_3 (5 - 23 wt.% in gabbros and 0.1 - 5 wt.% in cumulates), CaO (4 - 15 wt.% in gabbros and 0.1 - 6 wt.% in cumulates), TiO_2 (0.3 - 1.8 wt.% in gabbros and 0.1 - 0.2 wt.% in cumulates), and Na_2O (0.3 - 1.8 wt.% in gabbros and 0.1 - 0.3 wt.% in cumulates) are negatively correlated with MgO. These systematic trends in major elements are attributed to progressive differentiation by fractional crystallization. Cumulates, crystallizing at an early stage of the intrusion consist of mainly olivine and orthopyroxene and to a lesser extent of clinopyroxene, plagioclase.

The incompatible trace elements Zr, Y, Nb, Ta, Hf, V, Ba, Sr, and Sc show also a strong negative correlation with Mg. Cumulates among themselves do not show any correlation and have usually very low values of these elements. The compatible elements Co, Ni, and Cr are enriched typically in ultramafic parts of gabbroic intrusions such as cumulates and are positively correlated with MgO. Co and Ni are usually concentrated in sulfide minerals. Cr usually is found in Cr-spinel.

REE pattern from samples from the El Durazno, Las Aguilas, Manana, Virorco, El Fierro, La Verbena, Intihuasi, and San Francisco lenses are relatively flat with a La/Yb ratio between 0.93 and 5.15. The slight enrichment in light rare earth elements may be due to the occurrences of ortho- and clinopyroxene. Eu, which is compatible in feldspars, usually does not show distinct positive or negative anomalies, which is interpreted to be due to the removal or segregation of feldspars. The rare earth element pattern of drill core samples (cumulates) are typically lower than of gabbroic rocks. With the exception of a nearly pure orthopyroxene rock, all REE pattern are about one order of magnitude lower than gabbroic samples. REE pattern from drill core samples are relatively flat with a La/Yb ratio between 0.95 and 4.57. The flat chondrite normalized REE pattern supports the mineralogical and textural results that part of the Las Aguilas complex consists of ultramafic cumulates and associated mafic rocks. Taking all REE pattern of the different localities into account, a genetic relationship of the lenses can be assumed.

The Sr and Nd isotopic evolution lines of the samples of the Sierras de San Luis do not show any correlation, making it difficult to use the isotopic signature of the rocks for geochemical interpretations. The reason for the different trends may be either a inhomogeneous mantle source, mixing of different mantle magmas, or crustal contamination.

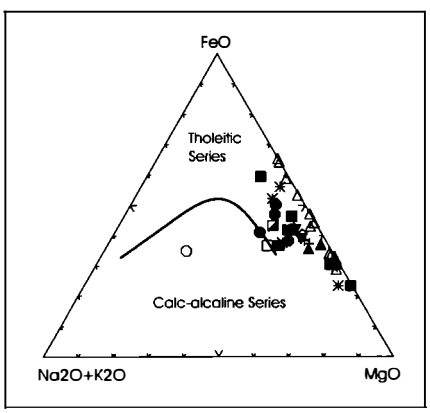

Fig. 2

The gabbroic intrusion follows a tholeitic trend. The open circle is a mafic dike crosscutting the basement and may be related to Teriary volcanism in this area

As seen in Figure 2 all mafic-ultramafic samples follow a tholeitic trend. Only one basaltic dike found in San Francisco, which is probably related to the Tertiary volcanism, falls into the calcalkaline field.

The Sierras de San Luis appears to have formed as a result of a period of normal subduction followed by a marked continent - continent collision representing deep levels of a continental margin. A belt of differentiated mafic and ultramafic bodies consisting of complexes of norite, hornblende norite, hornblende gabbro, orthopyroxenite, harzburgite, dunite, and associated metabasalts was developed during this orogeny. Variation in isotope compositions indicate that the gabbroic intrusion was evidently not homogeneous in composition. An inhomogeneous mantle source or mixing of several mantle derived magmas in combination with crustal contamination and fractional crystallization were the main factors controlling the evolution of these intrusive bodies.

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