OLIGO-MIOCENE IGNIMBRITIC VOLCANISM OF NORTHERN CHILE (ARICA REGION): STRATIGRAPHY AND GEOCHRONOLOGY

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INTRODUCTION

The Central Andes is a mountain range formed in an active continental convergent margin, generating large volume of subduction-related magmas. During the Late Cenozoic, the calc-alkaline emisions have been mainly concentred in the Cordillera Occidental of the Central Andes, whereas shoshonitic, alkalin and silicic back-arc magmas occur in the Altiplano and Cordillera Oriental (eg. Sébrier and Soler, 1991). Detailed studies about composition, distribution, age and tectonic environment of these rocks are scarce. In the Cordillera Occidental, along 500 km from North Chile to South Peru, large volume of ignimbrites, dated in 25 to 16 Ma, have been described (eg. Mortimer et al., 1974; Tosdal et al., 1981; Naranjo and Paskoff, 1985; García, 1996; Schröder and Wörner, 1996, Parraguez, 1998). We present here new data about the stratigraphy, K-Ar geochronology, petrography and the preliminary geochimistry of the 25-19 Ma ignimbritic volcanism of northernmost Chile (Arica region) (Fig. 1A). In this region, according to their degree of deformation and volume of sedimentary intercalations, the ignimbrites have been grouped in the two differnt units, that have been given different ages ranging from Cretaceous to Pliocene (Salas et al., 1966).

THE IGNIMBRITES OF THE ARICA REGION

The Oligo-Miocene (25-19 Ma) ignimbrites are subaerial, silica and K-rich and large in volume. They have been grouped in Oxaya and Lupica formations. The Oxaya Fm forms the western flanck of the Cordillera Ocidental, extending as far as the Pacific Ocenan by ~150 km, in gently folded beds. The

Lupica Fm, that outcrops immediately to the east, is strongly folded and thrusted such that the contact with Oxaya Fm is, in general, tectonic and thus their original relationships are masked.

Oxaya Formation. Is the more representative and extensive ignimbritic unit in Arica region, where conformably overlies and underlies sediments, respectively of the Azapa and El Diablo formations, respectively (Salas et al., 1966; Vogel and Vila, 1980; Parraguez, 1998). This succession unconformably covers to Mesozoic rocks. The Oxaya Fm (sensu García, 1996; Parraguez, 1998) is comprised of 4 to 6 welded, silicic, ignimbrite sheets, separated by minor sedimentary intercalations. West of the Oligo-Miocene arc the ignimbrites were deposited in alluvial pediment planes. Their thickness, welding and corseness systematicaly decrease westward. At the Pampa Oxaya, type locality of the formation, the sheets form a vaste and thick (~1000 m) plateau, although a more complete section is exposed in the Codpa-Sucuna region (Fig. 1B). The lower ignimbrites (25-24 Ma) are medium-volume, with the two oldest units (~25 Ma) exposed only in the Camarones valley, whereas an different ~24 Ma ignimbrite is exposed only in the Lluta valley. The thickest flow (200-600 m), a brown-colored unit named here Livilcar Ignimbrite (~23 Ma), is, however, only exposed in the Lluta and Azapa valleys. Over the Livilcar Ignimbrite we recognize a slightly thiner unit (~23 Ma, 50-150 m) characteristically pink in color. However, the most continuous and extensive deposit of the Oxaya Fm is a brown and grey-clored unit, that we designate Oxaya Ignimbrite (~21 Ma), with a mean thickness of 100 m, wich provides a superb regional stratigraphic marker. Only within the study area, it covers a surface of 15000 km^2, with a minimum estimated volume of 1500 km^3. Over the Oxaya Ignimbrite are scattered outcrops of thinner (<50 m), wedely distributed ignimbrites, grouped here as Sucuna Ignimbrite (~19 Ma). The large volume of some of these ignimbrites suggests they are very likely associated with large size collapse calderas, wich remain to be identified. Petrographically, these rocks are crystal-rich vitreous tuffs with scare volcanic lithics. They systematically contain crystal fragments of quartz (10-25%), sanidine (10-20%), plagioclase (3-10%), biotite (1-3%) and oxyhornblende (0-3%); pyroxene occur locally in Sucuna Ignimbrite. Chemical analyses of pumice clasts shows the composition to be high-silica (68-78% SiO_2), with dominant high-silica rhyolites.They show high-K calc-alkaline and dominant shoshonitic affinites (3-6% K_2O), with K_2O/Na_2O ratios ranging from 1 to 1,5.

Lupica Formation. Outcrops mainly in the Putre-Belén chaine (Fig. 1A), unconformably overlying the Belén Metamorphic Complex (Precambrian-Paleozoic) and covered by volcanics rocks and sediments of Miocene-Recent age (references in García, 1996). The Lupica Fm was tentatively assigned to the Cretaceous-Tertiary (Salas et al., 1966), however recent radioisotopic determinations indicate it to be Late Oligocene-Early Miocene in age (Aguirre, 1990; Muñoz and Charrier, 1996; García, 1996; Riquelme, 1998). From bottom to top, it comprised andesites and breccias, ignimbrites, sandstone and limestone, and andesites. This succession was deposited in a proximal volcanic-arc environment, locally extensional, with closed basins, where large volume of volcanoclastic and lacustrine sediments were accumulated (García, 1996). In the Belén-Lupica region is exposed one of its more representative sections (Fig. 1B), that in the middle part contains 4 to 5units of extensive welded ignimbrites, grey, brown, pink

and green in color. These tuffs show large mineral and chemical similarities to the Oxaya Fm ignimbrites, although locally exhibit strong hydrothermal alteration. The pyroxene and hornblende andesites and dacites of the Lupica Fm, with abundant plagioclase and absent sanidine, are dominantly calc-alkaline. The deformation of the Lupica Fm difficults to map the continuity of the ignimbrites, to separate them and to estimete their volume as in the Oxaya Fm.

GEOCHRONOLOGY

Recent radioisotopic determinations have been essential to our understanding of the age of the ignimbritic succession in the region. A compilation of 16 published and 27 new ages is summarized in Fig. 1C, all by the K-Ar method and mostly on biotite. The new values (Geochronology Laboratory of the SERNAGEOMIN) will be fully reported in García and Gardeweg, et al. (in prep.). For the ignimbrites of the Oxaya Fm 27 determinations indicate an age range from 25 to 19 Ma (Mortimer et al., 1974; Naranjo and Paskoff, 1985; García, 1996; Parraguez, 1998; this work). In the lower ignimbrites, the four existing data are close to ~25,5 Ma while other two values are identical to 23,7±0,8 Ma. The Livilcar and pink ignimbrites, that overlies it, yielded ages close to ~23 Ma. Eleven determinations in the Oxaya Ignimbrite yielded a weighted mean age of 21,3±0,7 Ma, whereas in the Sucuna Ignimbrite five data yielded a weighted mean age of 19,3±0,8 Ma. Sixteen age determinations on the Lupica ignimbrites of the Fm range from 25 to 18 Ma (Aguirre, 1990; Muñoz and Charrier, 1996; García, 1996; Riquelme, 1998; this work), values that closely match the ages for ignimbrites of the Oxaya Fm. In fact, two of the lowermost units are ~25,5 Ma, while in an intermediate ignimbrite in Chucal two results of ~23 Ma have been obtained in addition to an other age of ~23 Ma in Belén. Four scattered samples have ages close to 21 Ma, very similar to that of the Oxaya Ignimbrite. Finally, seven scattered determinations in upper flows yielded ages from 18,6 to 19,9 Ma, consistent with the ages of the Sucuna Ignimbrite.

CONCLUSIONS

In the Arica region, the large-volume Late Oligocene-Early Miocene ignimbrites occurs between 25 and 19 Ma. The western outcrops (Oxaya Fm) are weel preserved showing characteristicaly distals facies and mild defromation. In the eastern outcrops (Lupica Fm) the ignimbrites are intercalated with arc-lavas and sediments, and they are strongly deformed. The strong difference in the stratigrphy and deformation style reflects a difference in tectonic environement during deposition (plateau-type surface for Oxaya and intramontaneous basins for for Lupica) and a difference in strain of the deformation post-depositional, concentrated in the fold and thrust belt Belén (García, 1996). The dominantly shoshonitic character, in addition to the abundance of sanidine, suggests a back-arc origin for the ignimbrites.

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