Comunicaciones, N° 35 (1985): 93 - 96
Departamento de Geología – Universidad de Chile – Santiago

VOLCANISMO CENOZOICO SUPERIOR DEL NORTE DE CHILE: CARACTERISTICAS, EDADES Y DISTRIBUCION

UPPER CENOZOIC VOLCANISM OF NORTHERN CHILE: CHARACTERISTICS, AGES AND DISTRIBUTION

M. GARDEWEG P.; C. F. RAMIREZ
Servicio Nacional de Geología y Minería, Casilla 10465, Santiago, Chile

The modern volcanic chain of Northern Chile is part of the Central Andes (16°-28°S, Fig. 1), one of the three segments of Upper Cenozoic volcanism within the Cordillera de Los Andes. From Arica (18oS) to Copiapó (28oS), since the Miocene, a continuous and voluminous volcanic activity developed along the Main Andean chain, whereas south of Copiapó, only isolated Miocene volcanic outcrops have been reported. The Central Andes forms a major volcanic province, with large rhyolitic and dacitic ignimbrite sheets, and andesitic to dacitic composite stratocones and/or dome complexes. In earlier works the ignimbrites were considered the substratum of the stratocones (PICHLER & ZEIL, 1972) but during the last 10 years, more detailed mapping, supported by K-Ar dating demonstrated that both, ignimbrites and strato volcanoes developed together since the lower Miocene, intertonguing their products up to the Pliocene (MORTIMER et al., 1974; BAKER, 1977; RAMIREZ & GARDEWEG, 1982; MARINOVIC & LAHSEN, 1984; GARDEWEG & RAMIREZ, 1985).

The first geological works in Northern Chile considered the ignimbrites as a large single volcanic unit of Pliocene age (Formación Liparítica). In subsequent surveys they received local names as Oxaya, Huaylas, Altos de Pica and San Bartolo formations, being also mapped as individual sheets. In many cases however, their ages, extention, source and relation with the volcanoes remained unknown. The ignimbrites are widely distributed, although they crop out mainly in the axis of the volcanic chain, where they are interbedded with lavas and are characteristically almost devoid of sedimentary intercalations. The extense ignimbrite sheets crop out as far 150 km. from the volcanic axis, reachig in some cases the Pacific Ocean, across the Cordillera de la Costa (Fig. 1). These distal sheets are interbedded with thick Miocene sedimentary sequences, which is also observed in the Argentina Puna, east of the volcanic chain (SALFITY et al., 1984). Ignimbrite ages range from 23 Ma (LAHSEN, 1982) in Arica (Oxaya formation). to 0.75 in Collacagua (BAKER, 1977).

In other volcanic provinces of the world, most large volume ash-flow sheets can be associated with caldera sources. In the Central Andes, however, only few calderas have been identified, mainly because of the large size of these structures, the lack of detailed mapping and extensive mantling by younger stratovolcanoes. Recently, Landsat imagery enabled BAKER (1981), among others, to identify a few major calderas, and regional mapping lead us (GARDEWEG & RAMIREZ, 1985) to identify a few others. This suggests that a large number of these structures should be present in the Central Andes. The ignimbrites are calcalkaline in composition and by the chemistry of cognate inclusions and glass are classified as dacites, rhyodacites and rhyolites, but whole rock chemical

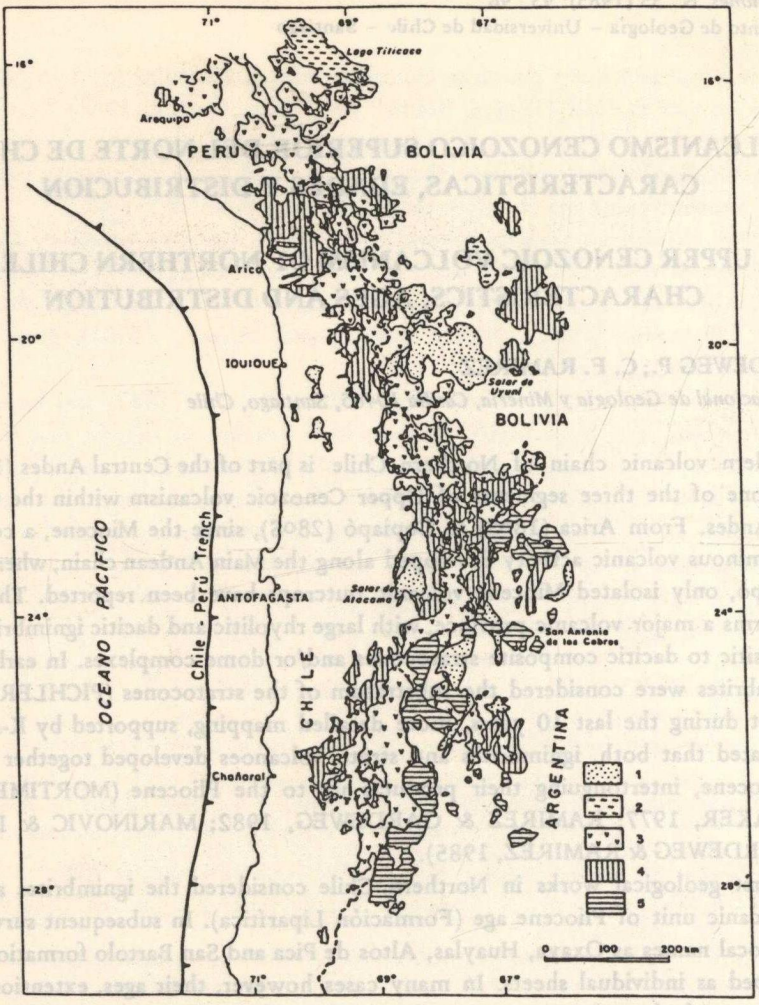

Fig.1. Distribution of the Upper Cenozoic volcanism in the Central Andes. 1. Salar; 2. Lakes; 3. Lavas associated to stratocones, andesites and dacites, less abundant basalts and rhyolites (Miocene-Quaternary); 4. Dacitic and rhyolitic ignimbrites (Miocene-Quaternary); 5. Undifferentiated volcanics (Argentina's Puna).

Fig.1. Distribución del volcanismo del Cenozoico Superior en los Andes Centrales. 1. Salares; 2. Lagos 3. Lavas asociadas a estratoconos, andesitas y dacitas, basaltos y riolitas menos abundantes (mioceno-cuaternario); 4. Ignimbritas dacíticas y riolíticas (mioceno-cuaternario); 5. Volcanicos indiferenciados (Puna Argentina).

analyses may result more basic due to the abundance of lithic fragments or crystal concentrations. Plagioclase is the most abundant crystal; biotite, hornblende, quartz and sanidine, occur in various proportions, sphene, apatite, zircon and magnetite are commonly found as accessory minerals. Volumes of individual sheets vary between 0.4 and 300 km^3; where calderas have been studied, the intracaldera facies may reach 450 km^3 to a bulk estimate of 1,500 km^3. Owing to the mobility of the flows, they spread far of their source areas extending up to 60 km. Ignimbrites grade between two main types; a pumiceous one containing abundant pumice fragments in a matrix of crystals and glass shards, variety that grades to an homogeneous extreme ("porphyric")

that contains few cognate inclusions and crystals in a matrix of glass shards. Co-ignimbrite ash is being found in many places as intercalated sediments in slopes and valleys, far from the main volcanic chain.

The distribution of the stratocones and dome complexes is restricted, in Chile, to the main Andean axis where a N-S fault system, together with NW-SE and SE-SW systems control their location (LAHSEN, 1982). Even though this activity started in the Lower Miocene, only since the Mid-Miocene it shows continuous development until today. The present day volcanic activity in the Central Andes is weak compared to the magnitude and intensity of it in the Southern Andes (33°-45° South). In the north (17°30'S) and south (25°-28°S) ends of the area, two volcanic belts are clearly defined, a western one of Miocene age and an eastern of Pliocene and Quaternary age, mainly concentrated along the frontier with Bolivia and Argentina. In between (20-25°S) the volcanic activity overlaps since its onset in the Miocene. The erosion features of the stratocones of northern Chile are strickingly different to the rest of the country and to other volcanic fields of the world. The extremely arid climate that characterizes this area, at least since the Miocene, keeps almost intact old volcanic structures that in the rainy southern Chile only show remanants of flows and deeply eroded skeletons of volcanoes. Also the ignimbrites are well preserved, even some of their pumice rich tops and fronts (RAMIREZ and GARDEWEG, 1982).

Chemistry of the lavas is similar to the ignimbrites but both are different form those from southern Chile. Rhyolitic and dacitic compositions predominate in the ignimbrites hornblende andesites. Biotite an hornblende dacites are also ommon, while rhyolites, characteristically vitrophyric, and olivine basalts are scarce. These volcanics form a typical rhyolite - dacite - andesite - basalt calcalkaline association, including a large proportion of andesites. They differ from other volcanic associations including a large proportion of andesites. They differ from other volcanic associations related to subduction zones in their high K contents and enrichment in Rb and Ba. The easternmost outcrops, near 23°S, show $K_2O/Na_2O > 1$ and belong to the shoshonitic series, that characterize most of the Bolivian volcanism (DERUELLE, 1978).

North-south variations of the Andean volcanic chain and their relation to discontinuites on the underlying subduction zone have been studied by many authors. BARAZANGI and ISACKS (1976), based on hypocenters defined a steep dipping (25° to 30°E) seismic zone in the segment beneath southern Peru and northern Chile (about 15° to 27°S), segment where the distance between the trench axis and the volcanoes varies from about 250 km. in the north to a maximum of about 370 km. near the 24°S. Within this segment, north south variation in the onset, distribution and lithology of the volcanic activity are observed. Based on these differences and the distance of the "volcanic line" to the trench axis, a few subsegments can be defined. Some limits of these subsegments coincide with EW and NNW-SSE volcano alignments, which in Argentina control the formation of Cenozoic continental basins (SALFITY, et al., 1984).

REFERENCES

Baker, M.C.W., 1977. Geochronology and volcanology of Upper Cenozoic volcanic activity in northern Chile and south-west Bolivia. Ph.D.Thesis. The Open University, England.

Baker, M.C.W., 1981. The nature and distribution of Upper Cenozoic ignimbrites centres in the Central Andes. J. Volcanol. Geotherm. Res. 11, 293-315.

Barazangi, M. Isacks, B.L., 1976. Spatial distribution of earthquakes and subduction of the Nazca plate beneath South America, Geology, 4, 686-692.

Gardeweg, M., Ramírez, C., 1985. Hoja Río Zapaleri, Serv. Nac. Geol. Min. Chile, Carta Geológica 1:250.000 in press.

Lahsen, A., 1982. Upper Cenozoic volcanism and tectonism in the Andes of northern Chile, Earth Sci. Rev. 18, 285-302.

Marinovic, N., Lahsen, A., 1984. Hoja Calama, Región de Antofagasta, Serv. Nac. de Geol. y Min. Carta Geol. de Chile.

Mortimer, C.; Farrar, E.; Saric, N., 1974. K-Ar ages from Tertiary lavas of the northernmost Chilean Andes, Geol. Rundsch. 63, 484-490.

Pichler, H., Zeil, W., 1972. The Cenozoic rhyolite-andesite association of the Chilean Andes. Bull. Volcanol. 35, 424-453.

Salfity, J.; Gorustovic, S.; Moya, M.C.; Amengual, R.; 1984. Marco tectónico de la sedimentación y efusividad cenozoicas en la Puna Argentina. Noveno Congreso Geológico Argentino, S.C. Bariloche, Actas I:539-554.