Nº 35 / 1985

ISS - 0069 - 357X

Una Revista de Geología Andina

COMUNICACIONES

Volumen especial

EVOLUCION MAGMATICA DE LOS ANDES

F. Hervé
F. Munizaga (Editores)

DEPARTAMENTO DE GEOLOGIA
FACULTAD DE CIENCIAS FISICAS Y MATEMATICAS
UNIVERSIDAD DE CHILE

Comunicaciones, N° 35 (1985): 191 - 194
Departamento de Geología — Universidad de Chile — Santiago

LAS ROCAS VOLCANICAS DEL CERRO ACONCAGUA - CORDILLERA PRINCIPAL (32°S), ARGENTINA

THE VOLCANIC ROCKS OF CERRO ACONCAGUA - CORDILLERA PRINCIPAL (32°S), ARGENTINA

RAMOS, V.A.*; MAHLBURG KAY, S.**; CINGOLANI, C.*** AND KAWASHITA, K.****

* *Servicio Geológico Nacional, Argentina.*
** *INSTOC (Institute for the Study of the Continents), Cornell University, Ithaca, New York 14850 U.S.A.*
*** *Universidad de La Plata - CIG, Argentina*
**** *Universidad de Sao Paulo, Brazil.*

Although several geological reconnaissance studies have been done in the Cordillera Principal within the Aconcagua region, the geological framework of Cerro Aconcagua itself has only recently been studied. Cerro Aconcagua (6959-7021 meters) is the highest peak in the Andes and is located over the volcanically quiet, modern zone of shallow subduction. Unlike other Andean high peaks, which are principally late Cenozoic strato-volcanoes (Ojos del Salado, Tupungato, etc.), the Aconcagua massif consists of tectonically elevated Mesozoic and Tertiary sedimentary and volcanic rocks. The purpose of this study is to provide new data on the stratigraphy and structure of Cerro Aconcagua, as well as the first geochemical analyses and K-Ar dating of the volcanic rocks.

The Aconcagua massif consists of a lower sedimentary sequence and an upper volcanic sequence separated by an angular unconformity. The oldest unit of the lower sequence is a series of redbeds assigned to the Tordillo Formation (Late Jurassic). This unit is overlain by a series of limestones and interbedded marls with abundant marine fossils of Neocomian age (Mendoza Group) that grade transitionally into thin laminated limestones and dolostones interfingered with thin gypsum layers (Huitrin Formation) of Late Barremian to Early Aptian age. A proximal facies consisting of a thick sequence of conglomerates and red sandstones with conspicuous cross-lamination conformably overlies the evaporitic beds.

The major part of the Aconcagua massif is composed of the upper volcanic sequence. Volcanic rocks in the Aconcagua region were divided by Yrigoyen (1976) into two units: a gently dipping unit assigned to the Abanico Formation (Late Cretaceous - Early Tertiary) and a flat-lying unit of andesites assigned to a possible Oligocene age. Later, the entire sequence was interpreted as belonging to the Farellones Formation of Oligocene-Early Miocene age by Munizaga and Vicente (1982). Detailed field mapping of the northern and western slope of the Aconcagua massif confirms that two units occur: a lower moderately northwesterly dipping unit and an upper subhorizontal unit. These units are separated by a distinct unconformity that dips about 20° and is exposed between 5200 and 5500 meters altitude.

The lower volcanic unit consists of a 2500 meter thick sequence dominated by andesitic breccia, agglomerates and tuffs with minor intercalated andesitic to dacitic lava flows. This sequence has been intruded by subvolcanic bodies of hornblende-bearing andesites of various sizes and cut by dacite porphyry dykes. The upper unit is a poorly exposed sequence of andesitic breccias and lava flows that are heavily altered to limonite and contain abundant secondary gypsum and sulfur. The upper series has a thickness of 1500 meters.

The eruption of the volcanics in the Aconcagua massif predates the major compressional deformation in the region as they are carried in the thrust sheets that shorten the main Cordillera in this region by as much as 27 km. This thrusting is responsible, in part or totally, for the high relief in the region today and is thought to be associated with the shallowing of the subduction zone that ended volcanism in this segment of the Andes.

The only previous dating on the Aconcagua massif is a K/Ar age of 8.5 ∓ 0.2 Ma obtained by Sillitoe (1977) on biotite from a granodiorite porphyry along the Rio Vacas valley on the eastern slope of Aconcagua. This granodiorite porphyry is equivalent to the dacite porphyries that intrude the lower volcanic unit on the western slope and is probably equivalent to other granodiorites ranging in age from 7-10 Ma (Munizaga and Vicente 1982) along the Chile-Argentine border. A date of 15 Ma was reported from Drake by Munizaga and Vicente (1982) on a trachytic dyke (AC102) near Puente del Inca. This dike is thought to be younger than the Aconcagua lower volcanic sequence. New whole rock K-Ar dates from samples from the lower Aconcagua volcanic unit between the platform at 5200 meters (AC85) and the Plaza de Mulas Superior (AC91) at 4200 meters altitude range from 9.6 to 15.8 Ma and are given in Table I. Although some samples have high atmospheric argon values, isotopic homogenization of the K-Ar system appears to have occurred between 10.3 to 15.9 Ma. These new dates may not represent crystallization ages as biotites, amphiboles and groundmass of the samples show effects of alteration and oxidation. In particular, the 15.9 Ma age in the middle of the sequence and the date on the Puente de Incas dacite suggest parts of the lower unit must be at least 15.9 Ma and may be equivalent to the Campo de Ahumada-Juncal belt ranging in age from 18 to 16 Ma in Chile to the west (Munizaga and Vicente 1982). If this is the case, further work needs to be done to explain the meaning of the 10 Ma age obtained on the Aconcagua samples.

TABLE I

K-Ar DATING OF THE LOWER VOLCANIC SECTION OF ACONCAGUA
EDADES K-Ar DE LA SECCION VOLCANICA INFERIOR DEL ACONCAGUA

SPK	*SAMPLE NO.*	*ROCK TYPE*	*%K*	$\frac{Ar^{40}_{rad}\ cc}{g \times 10^{-6}}$	*Ar atm.* %	*AGE* Ma
5657	AC85	andesite	1.4885	0.57	57.05	9.8 ∓ 0.7
5654	AC88a	andesite	1.6454	0.66	48.66	10.3 ∓ 0.7
5651	AC89	dacite?	2.1731	0.81	79.60	9.6 ∓ 2.2
5655	AC90	andesite	1.7050	1.05	47.18	15.8 ∓ 0.4
5652	AC91	andesite	1.6599	0.67	62.20	10.3 ∓ 0.9

K-Ar dating done at Centro de Pesquisas Geocronológicas, Instituto de Geosciencias, Universidade de Sao Paulo, Brazil.

TABLE II

ANALYSES OF ANDESITES AND DACITES FROM THE ACONCAGUA MASSIF

ANALISIS DE ANDESITAS Y DACITAS DEL MACIZO DEL ACONCAGUA

	AC92	AC91	AC90	AC88	AC87	AC86	AC85	AC94	AC93	AC102
SiO_2	64.10	58.13	62.91	60.19	64.41	69.23	60.27	63.04	63.32	67.93
TiO_2	0.67	0.90	0.75	0.78	0.60	0.47	0.76	0.64	0.62	0.47
Al_2O_3	17.26	17.77	17.16	17.23	16.59	14.21	17.78	17.29	17.10	16.67
FeO	5.14	5.91	5.72	5.99	4.05	3.66	5.41	5.10	4.48	2.20
MnO	0.07	0.09	0.08	0.09	0.06	0.06	0.11	0.07	0.06	0.03
MgO	1.34	1.58	1.03	4.00	2.77	0.20	4.02	1.11	2.62	1.02
CaO	5.18	9.79	6.38	5.75	4.45	5.64	5.80	6.38	4.54	3.22
Na_2O	4.01	3.81	3.88	3.95	4.53	3.80	4.06	3.78	4.75	5.62
K_2O	2.07	1.83	1.90	1.91	2.41	2.61	1.68	2.44	2.37	2.77
P_2O_5	0.16	0.19	0.18	0.11	0.13	0.12	0.13	0.15	0.13	0.06
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
La	19.3	20.0	19.9	19.6	19.6	23.3	18.8	26.2	21.4	20.3
Ce	37.8	40.8	39.5	40.6	39.5	51.3	45.1	53.4	42.0	40.8
Nd	19.2	21.9	21.0	19.6	19.9	24.7	20.7	27.9	22.8	19.0
Sm	4.18	4.41	3.91	4.51	3.94	5.01	4.16	5.18	4.26	3.31
Eu	0.999	1.15	1.05	1.07	0.852	1.07	1.09	1.09	0.912	0.826
Tb	0.518	0.490	0.416	0.583	0.451	0.577	0.566	0.650	0.524	0.278
Yb	1.81	1.35	0.938	2.135	1.68	1.96	1.85	2.45	1.86	1.04
Lu	0.240	0.201	0.144	0.313	0.241	0.287	0.266	0.360	0.272	0.113
Sc	11.7	14.8	10.4	18.0	10.1	6.7	17.1	8.8	11.7	4.70
Hf	3.3	3.8	3.9	4.1	3.6	4.5	4.3	5.2	3.8	3.61
Ta	0.728	0.60	0.687	0.69	0.668	0.904	1.04	1.05	0.659	0.419
Cr	18.2	70.0	27.8	107.0	20.8	17.5	90.2	10.5	14.5	20.8
Ni	–	22.5	7.0	26.6	11.9	1.5	25.9	5.6	9.5	5.89
Co	9.1	19.9	7.6	19.3	10.1	3.5	20.0	10.2	12.3	4.48
Th	5.4	4.6	4.0	4.2	6.3	6.6	6.2	8.4	5.8	3.97
U	1.8	1.3	1.2	1.4	2.9	1.8	1.7	3.1	2.3	1.94
Ba	483.5	397.0	394.0	450.5	6591.3	13.3	402.4	431.8	482.8	865.4
Cs	1.9	1.9	6.4	2.5	1.5	1.6	4.3	4.8	1.2	1.32

Trace elements analysed by NIAA at Cornell University. Concentrations are keyed to sample FeO concentrations (anhydrous values) which were used as an internal flux monitor. Major element analyses were obtained on fluxed glasses from rock powders by electron microprobe at Cornell University.

Table II lists major and trace element analyses for 7 samples from the lower volcanic unit (AC85-92), a dyke (AC94) and a subvolcanic body (AC93) intruding the lower volcanic unit and the trachytic dyke from Puente del Inca (AC102). Chemically, these samples are similar to other Andean cycle volcanic and plutonic rocks in the main Cordillera of the central Andes (28-34°S). Andesites (AC90-92) and a dyke (AC94) from the lower part of the sequence have higher FeO/MgO ratios (3.8-5.5) than those (AC85-88) from the upper part of the sequence and the subvolcanic body (AC93). The principal phenocryst minerals are plagioclase and amphibole. Cr and Ni contents are variable, but can be explained by the occurence of occasional grains of diopside in the most Cr-rich samples (i.e., AC88, 107 ppm Cr) suggesting a more mafic precursor magma. Cr-rich samples also tend to have higher Sc and MgO, consistent with the presence of the Mg-rich clinopyroxenes. The REE patterns of most of the samples are characterized by ratios of La/Sm from 3.9-5.0, La/Yb from 9.2-11.9, and Eu/Eu* from 0.68-0.82. AC91 and AC90 have rations of La/Yb of 14.8 and 21.2 and Eu/Eu* of 0.85 and 0.89 respectively. The 15 Ma old Puente del Inca dyke, AC102, is distinct; it has La/Sm = 6.1, La/Yb = 19.5, Ba/La = 43, relatively lower Ta and Th and higher Ba.

For samples of similar SiO_2 content, the REE patterns of most Aconcagua samples are flatter than those from the lower to middle Miocene (dates range from 11-16 ma) Cerro de las Tortolas Formation (La/Yb = 10-30) to the north (29-31°S) (Maksaev et al., 1984) and the late Cenozoic lavas from Tupungato and Marmolejo (La/Yb = 18-27) to the south (33-34°S) (Lopez-Escobar et al., 1977), and generally steeper than those of late Cenozoic volcanics from the main part of the Southern Volcanic zone (La/Yb = 5-12) (SVZ, south of 34°S). They are similar to those in andesites from the Upper Oligocene-Lower Miocene (18.9-27 ma) Doña Ana Formation ((11-13) Maksaev et al., 1984) to the north (29-31°S). Ratios of alkali and REE elements to high field strength (HFS) elements are distinctly lower than those in the SVZ, slightly lower than those in most of the Doña Ana Formation, and similar to those in the Tortolas Formation. AC90 and AC91 are more similar to the Tortolas andesites.

If the lower Aconcagua volcanic unit is equivalent in age to the Tortolas Formation as suggested by the K-Ar ages, then the history of the interaction of the flattening of the subduction zone and the volcanic chemistry is different in the Aconcagua region than in the central part of the modern region of flat subduction (30°S). The steeper REE patterns in the Tortolas Formation have been interpreted to result from a greater role for garnet in the source area as a result of the beginning of flattening of the subduction zone. A major difference to the Aconcagua region is that major deformation in the north preceeded the eruption of the Tortolas, while major deformation of the south postdated the eruption of the lower Aconcagua volcanic unit. The timing of structural thickening of the crust thus postdates the eruption of the Aconcagua rocks and predates the Tortolas Formation. Another possibility is that the Aconcagua volcanic rocks are actually older, possibly equivalente in age to the latest Doña Ana and predate flattening of the subduction zone. On the other hand, the Aconcagua region is close to the southern boundary of the flat slab region and the timing of flattening and the interaction with the preexisting crust may be different than in the central part of the flattened zone to the north.

REFERENCE

Lopez-Escobar, L., Frey, F.A. and Vergara, M. 1977, Andesites and High-Alumina basalts from the central-south Chile High Andes: Geochemical evidence bearing on their petrogenesis. Contrib. Mineral. Petrol.,63, 199-228.

Maksaev J., V., Moscoso D., R., Mpodozis M., C. and Nasi P., C., 1984, Las unidades volcánicas y plutónicas del Cenozoico superior en la alta Cordillera del Norte Chico (29°-31°S): Geología, alteración hidrotermal y mineralización, Rev. Geol. Chile,21, 11-51.

Munizaga, F. and Vicente, J.C., 1982, Acerca de la zonación plutónica y del volcanismo Miocénico en los Andes de Aconcagua (Lat. 32-33°S): Datos radiométricos K-Ar, Rev. Geol. Chile, 16, 3-21.

Sillitoe, R., 1977, Permo-Carboniferous, Upper Cretaceous, and Miocene Porphyry copper type mineralization in the Argentinian Andes, Econ. Geol.,72, 99-109.

Yrigoyen, M., 1976, Observaciones geológicas alrededor del Aconcagua, I[er] Congr. Geol. Chileno, Actas, V. 1, p. A168-190.