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EVENTOS MAGMATICOS Y METALOGENESIS RELACIONADA EN LA REGION DE ANTOFAGASTA CHILE.

MAGMATIC EVENTS AND RELATED METALLOGENESIS IN THE ANTOFAGASTA REGION, NORTHERN CHILE.

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The available geological, geochronological and mining data of the Antofagasta Region allowed to establish that the metallic ore deposits are mainly of hydrothermal origin and were mostly emplaced in volcanic and intrusive rocks of Late Paleozoic to Pliocene ages. The regional distribution of igneous rocks of different geologic ages coincides with characteristic groups of ore deposits, fact that added to their hydrothermal origin strongly suggest that the genesis of the metallic ore deposits is closely related to the magmatic processes.

The earliest magmatic event is represented by granitoids of Ordovician-Silurian age that crop out in Sierra de Moreno, Cordón de Lila and Sierra de Almeyda. This plutonism is time coincident with a major deformative event that affected the Andean Cordillera of Northern Argentina and Chile (Ocloyic tectonic phase; Coira et al., 1982), but its origin can not be solved yet with the available petrological data. No metallic minerallization is related to this magmatic event.

The second magmatic event was a Late Carbonifeous to Triassic plutonism and volcanism developed in the present Precordillera and Andean Cordillera of Antofagasta and plutonism in the Coastal Range. According to the geochronological data the magmatic activity was almost continous between Late Carboniferous and Triassic times, but minor concentrations of the radiometric ages suggest pulses of increased magmatic activity during the Late Carboniferous (290 to 300 Ma), Permian (260 to 270 Ma) and Late Triassic (220 to 230 Ma). In the Precordillera and Andean Cordillera this second magmatic event was characterized by the emplacement of granitoids as well as by a rhyolitic, dacitic and subordinate andesitic-basaltic volcanism. This association of volcanic and intrusive rocks can be interpreted as a result of the activity of a magmatic arc in a continental margin and corresponds to the northernmost portion of a magmatic belt extending continously for nearly 4.000 Km, from Neuquen Argentina to northern Chile (Coira et al., 1982). The largest ore deposits genetically related to this magmatism are the vein-stratiform copper hydrothermal deposits of the Tuina disctrict; besides them, there are minor copper and manganese veins and irregular bodies and silver-lead veins. The granitoids in the Coastal Range show chemical characteristics that indicate derivation from crustal melting, according to Berg et al., (1983). The available data are from the south part of the Region and are insufficient to establish a valid framework for the whole extent of the Range. Minor silver-lead veins were emplaced in this granitoids and in nearby areas.

The third magmatic event was a Jurassic to Early Cretaceous plutonism and volcanism developed in the Coastal Range, characterized by the emplacement of a batholith of diorite, gabbros, granitoids and minor syenites, as well as by an intense andesitic volcanism with subordinate basalts, dacites and rhyolites. Geochronological data indicate that magmatic activity was continous between Jurassic and Early Cretaceous times, with minor concentrations of radiometric ages during the Dogger (165 to 170 Ma), the Jurassic-Cretaceous boundary (140 to 145 Ma) and the Early Cretaceous (115 to 130 Ma) which can be interpreted as pulses of increased magmatic activity of another magmatic arc developed in a continental margin. The largest number of metallic ore deposits in the Antofagasta Region are genetically related to this arc. The most outstanding by their economic value are the stratabound copper deposits within Jurassic volcanic rocks and the copper veins emplaced in Jurassic plutons. During the Jurassic minor gold, silver and scarce iron and nickel-cobalt veins were also emplaced. During the Lower Cretaceous gold, copper, iron, manganese and polimetallic (copper-gold silver) ore deposits mainly of vein type were seated.

The fourth magmatic event was developed in a longitudinal belt in the central part of the Antofagasta Region during Late Cretaceous to Paleogene times. This event is clearly separated in time and space from the previous magmatism and was characterized by basaltic, andesitic, dacitic and rhyolitic volcanism, as well as by the emplacement of diorites, gabbros, granitoids and syenites usually with porphyric textures. Geochronologic data indicate a continous magmatic activity between 78 to 24 Ma, with minor concentrations of radiometric ages between 60 and 70 Ma, as well as 45 and 35 Ma wich can be also interpreted as pulses of increased magmatic activity. The chronologic and spatial association between the volcanism and plutonism, as well as the petrographic features allow to interprete them as the result of the activity of a new magmatic arc in a continental margin eastwards of the Jurassic-Early Cretaceous one. The major ore deposits of the Antofagasta Region are genetically related to this magmatic arc, including the large Oligocene porphyry copper deposits (Chuquicamata, La Escondida, El Abra) and a great number of epithermal silver and gold veins. Other minor deposits related with this magmatic event are hydrothermal copper, polimetallic (copper-gold-silver), antimony and cobalt veins, as well as minor copper, manganese and iron stratiform deposits.

The youngest magmatic event is represented by the development of a volcanic chain in the Andean Cordillera and Altiplano of the Antofagasta Region. This event began during the Miocene (18,2 Ma) and has been continous up to the present times. It is characterized by andesitic, dacitic, rhyolitic and minor basaltic volcanism, with related subvolcanic plutonism of dacitic, rhyolitic, monzonitic, granitic and andesitic composition. This volcanic chain represents an active magmatic arc in the southamericann continental margin, eastwards of the previous arcs. The most important metallic deposits related to this arc are the large irregular iron bodies of magmatic origin of the El Laco district. There are also minor silver, antimony and tin veins in the Nevados de Poquis area.

The magmatic arcs show a remarkable eastward shifting since Jurassic to present time. This shifting does not appear as a gradual or continuous process because the geochronological data indicate true "jumps" to the east (Fig. 1). These "jumps" occurred during the Late Cretaceous and the Miocene, preceded by tectogenic and orogenic phases (Peruana and Quechua tectonic phases) and short periods without magmatic activity. They are correlated with major events of regional reorganization and reorientation of lithospheric plates, such as the opening of Atlantic Ocean during the Late Cretaceous and the extinction of the northwest trending Pacific Farrellón rise to the end of the Oligocene with the subsecuent birth of the north-northeast trending Galapagos rise. Therefore, the shifting towards the east of the magmatic arcs since Jurassic time could be a consequence of crustal shortening due to deformation derived from the increased compressive stress during the major events of reorganization and reorientation of convergent plates, together with a possible erosion by subduction of the continental margin related to the same phenomenon.

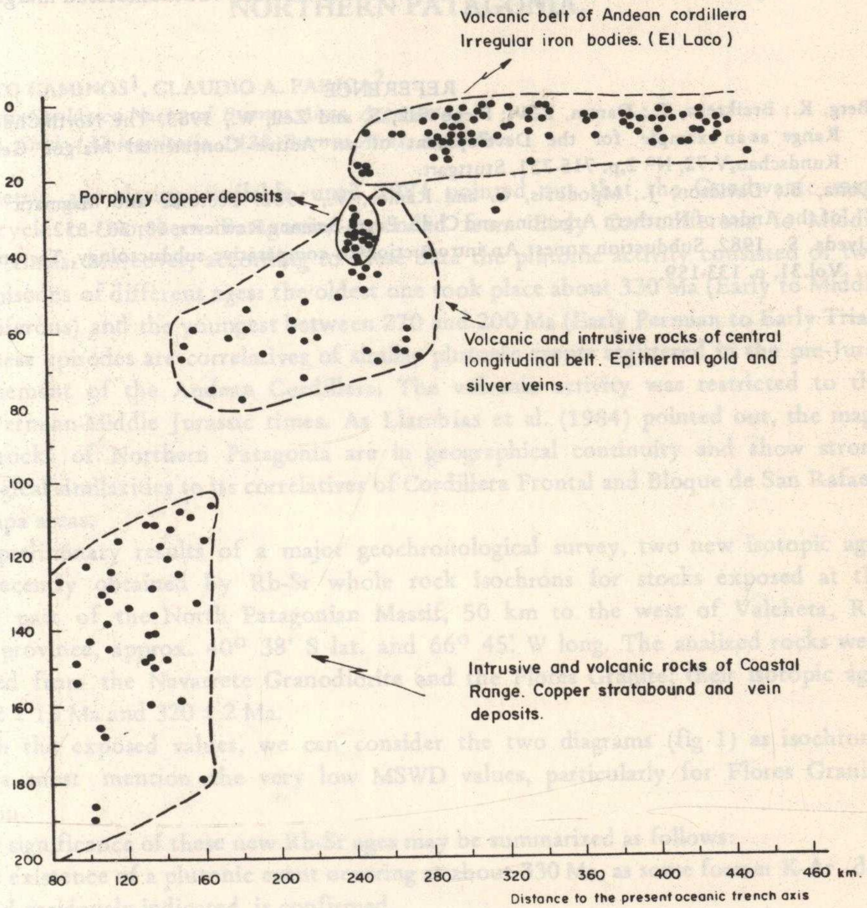

Fig. 1. A graph representing the relationship between the radiometric ages (200 to 0 Ma) of the igneous rocks of Antofagasta Region. and their distance to the axis of the present Peru-Chile oceanic trench. The main ore deposits type related to each magmatic event are also indicated.

Fig. 1. Relación entre edades radiométricas de rocas ígneas de la Región de Antofagasta y su distancia al eje de la fosa oceánica Chile-Perú actual. Se indican los principales tipos de yacimientos asociados a cada evento magmático.

The existence of different types of metallic ore deposits associated to each magmatic arc could result from different plate interactions influencing the magmatic activity in each period, but the depth of the erosion level of the oldest magmatic arcs also plays a role in the type of the presently exposed mineralization. Consequently, the presence of stratabound copper ore bodies related to the Jurassic volcanism could be a result of a Mariana type subduction (low compressional stress) and instead the porphyry copper deposits associated to the Late Cretaceous - Paleogene magmatism could be related to a Chilean type subduction (High compressional stress; UYEDA, 1982), which prevailed after the opening of the Atlantic Ocean, generating an increase of convergence ratios and compressive stress on the western southamerican margin.

REFERENCE

Berg, K.; Breikreuz, C.; Damm, K.W.; Pichowiak, S. and Zeil, W., 1983. The North-Chilean Coast Range as an example for the Development of an Active Continental Margin. Geologische-Rundschau,V.72, Nº 2,p. 715-731, Stuttgart.

Coira, B.; Davidson, J.; Mpodozis, C. and Ramos, V., 1982. Tectonic and Magmatic evolution of the Andes of Northern Argentina and Chile. Earth-Science Rewiews, 18, 303-332.

Uyeda, S., 1982. Subduction zones: An introduction to comparative subductology. Tectonophysics, Vol.31, p. 133-159.