Acta Geologica Sinica (English Edition), 2019, 93(supp.2): 43–44

Two Metallogenic Modes for Porphyry Copper Deposits in Middle Andes of South American: as Examples in Northern Chile and Northwestern Argentina

QIU Ruizhao[1], CHEN Yuming[1], CHEN Xiufa[1], ZHAO Hongjun[1], REN Xiaodong[2], ZHAO Like[2], ZHANG Cao[1] and WANG Liangliang[1]

[1] *Development and Research Center，China Geological Survey，Beijing 100037, China;*
[2] *China University of Geosciences (Beijing)，Beijing 100083，China*

Citation: Qiu et al., 2019. Two Metallogenic Modes for Porphyry Copper Deposits in Middle Andes of South American: as Examples in Northern Chile and Northwestern Argentina. *Acta Geologica Sinica* (English Edition), 93(supp.2): 43–44.

Abstracts: The western Andes of South America continent is a famous copper (gold) metallogenic belt in the world. Its metallogenic age ranges from 190 Ma to 6 Ma. Among them, the two large-scale mineralization for copper and molybdenum occurred in Eocene-Oligocene (28-43 Ma) and Miocene (5-16 Ma), and accounted for 82% and 94% of the known minerals, of which the Middle Andean belt is richest in resources (Butterworth et al., 2016). The close relationship between porphyry deposits and subduction is well established; however, there is no consensus on which subduction parameters primarily control the genesis of porphyry deposits (Richards, 2013). Based on the field investigation in Northwest Argentina and deep data analysis, there may be two metallogenic modes related to subduction and orogenic collapse in porphyry copper deposits in northern Chile and northwest Argentina is suggested in this paper. (1) Andean-type: Cretaceous porphyry copper deposits are located in the westernmost part of the northern Chile. Although their age gradually becomes younger to eastward, they are all distributed in a narrow area and superimposed by late porphyry copper belts (Marcos et al., 2018). Since the Atlantic expansion events, the continents of South America move westward and continuously “swallow” the Pacific subduction plate is regional, Slab-failure magmatism and metallogenesis caused by Slab-failure of the Pacific (Nazca) plate are also regional (Qiu et al., 2017). When the new subduction plate reaches a certain depth and eclogite facies rocks accumulate enough, Slab-failure magmatism will occur again. So, porphyry copper deposit belts of different ages are repeatedly positioned along reactivated lithospheric discontinuities (pre-existing Paleozoic mosaic belts and regional faults) (Qiu et al., 2013), and shows not subject to surrounding rocks (Vctor et al., 2010; Marcos et al., 2018). This metallogenic mode may also be the main mode for the Andean porphyry copper belt forming in the western part of the South American continent. (2) Orogenic collapse-type: Northwest Argentina is mainly located in the Puna Plateau. Geophysical data reveal that the crust is shortened along one-dimensional transverse direction. The South American craton block subducted under the Paleozoic orogenic belt and formed a thicker or double crust (Regnier et al., 1994). In the southern part of the Payenia volcano, 38-39 degrees to the east of the Andes Mountains, the existence of “hot roots” (Brasse et al., 2001), a decaying crust (33 km) (Yuan X et al., 2006), beneath the eastern Andean slopes, is consistent with the southernmost overflow volcano, and the geometric structure of the lower crust (Yuan X et al., 2006) is abnormally consistent with the Bouguer high conductive reservoir (Brasse et al., 2001) . It is suggested that the Puna Plateau in Northwest Argentina has indeed undergone the process of orogenic de-rooting, asthenospheric material and thermal upwelling. The main Andean mountains uplifted in the early Miocene (18-15 Ma), and the foreland ruptured in the middle-late Miocene (14-7.5 Ma) may mark the beginning of the collapse stage of the Andes orogenic belt, and then extend eastward. Development of a large number of near-north-south faults, central valley in Chile and several salt-lake basins in Northwest Argentina, can be took as shallow landmarks for the collapse of the orogenic belt. The collapse of the orogenic belt in Northwest Argentina and lithospheric de-rooting resulted in the lithospheric discontinuities reactivated, which formed in Paleozoic (Qiu et al., 2013), and large-scale magmatism-mineralization happened. Therefore, the large-scale copper (gold and molybdenum) mineralization in the Miocene (5-16 Ma) may be resulted in the collapse of the orogenic belt, and which supported by the peak U-Pb age of clastic zircons in the Mesozoic and Cenozoic stratigraphic units in the northern Newuken Basin (Brian et al., 2016).

The separation of the South American continent from the African continent is one of the most important geological events in the Mesozoic and Cenozoic. With the expansion of the Atlantic Ocean, the Pacific plate is continuously "swallowed" by the westward-moving South American continent. In this sense, porphyry copper deposits of Andean-type and orogenic collapse-type in Northern Chile and northwestern Argentina, and even Andean copper(gold) metallogenic belt forming in South America, they are not so much related to the subduction of the Pacific plate as to the opening of the Atlantic Ocean.

Key words: large-scale mineralization, Andean-type, orogenic collapse-type, Northern Chile and Northwestern Argentina

Acknowledgments: This work is granted by the international Science and Technology cooperation Program of China (ISTCP) (Grant No.2011DFA22460), Geological Investigation Program

* Corresponding author. E-mail: qiurrzz@163.com

of China Geological Survey (Grant No. DD20160118 and DD20190370), and Major Program of Development and Reform Commission of Guangxi Zhuang Autonomous Region, P.R. China (Grant No. 2017No.670).

References

Brasse, H., Soyer, W., 2001. A magnetoteluric study in the Southern Chilean Andes. *Geophysical Research Letters*, 28 (19), 3757–3760.

Brian, K.H., Facundo, F., Andres, B., 2016. Andean stratigraphic record of the transition from backarc extension to orogenic shortening: A case study from the northern Neuqu_en Basin, Argentina. *Journal of South American Earth Sciences*, 71:17–40.

Butterworth, N., Steinberg, D., Müller, R. D., 2016. Tectonic environments of South American porphyry copper magmatism through time revealed by spatiotemporal data mining. *Tectonics*, 35(12): 2847–2862.

Marcos, Z., Victor, M., Ricardo, B., 2018. Spatial coincidence and similar geochemistry of Late Triassic and Eocene–Oligocene magmatism in the Andes of northern Chile: evidence from the MMH porphyry type Cu–Mo deposit, Chuquicamata District. *International Journal of Earth Sciences*, 107:1097–1126.

Qiu, R.Z., Tan, Y.J., Zhu, Q., 2013. Metallogenic regularity of important metallogenic belts in China & adjacent areas. Beijing: Geological Publishing House. 1–596 (in Chinese).

Qiu, R.Z., Li, X.W., Zhou, S.,(trans.). 2017. Mesozoic assembly of the north American cordillera. Beijing: Geological Publishing House. 1–238 (in Chinese).

Richards, J. P., 2013. Giant ore deposits formed by optimal alignments and combinations of geological processes, *Nature Geosciences*, 2013, 6(11), 911–916.

Regnier, M., Chiu, J.M., Smalley, R., 1994. Crustal thickness variation in the Andean foreland and, Argentina, from converted waves, *Bulletin of the seismological society of America*, 84(4): 1097–1111.

Víctor, M., Tomás, A.A., Francisco, M., 2010. Geochronological and thermochronological constraints on porphyry copper mineralization in the Domeyko alteration zone, northern Chile. *Andean Geology*, 37 (1): 144–176.

Yuan, X., Asch, G., Bataile, K., 2006. Deep seismic images of the Southern Andes. In: Kay SM, Ramos V A (Eds.), Late Cretaceous to recent magmatism and tectonism of the Southern Andean Margin at the latitude of the Neuquen Basin (36–39°S) . *Geological Society of America*, Special Paper, 407. 61–72.

About the first author

Qiu Ruizhao, male, born in 1963 in Longyan City, Fujian Province; doctor; graduated from China University of Geosciences (Beijing); Researcher of，Development and Research Center, China Geological Survey. He is now interested in the study on the deep geology, regional mineralization and overseas geology and mineral resources. Email: qiurrzz@163.com; phone: 010-56315775, 18910897820.