Tectonics of a shear zone linked to polymetallic mineralization by Zn-Ag-Pb: The Pasco Project, Peru

L. Ayala, F. Solano, P. Solano, D. Noone
GPM Metals Peru. Miraflores, Av. 28 de julio 200, dpto. 203

ABSTRACT
Between Huachon and Corralcancha (Eastern Cordillera), it has been identified a NW-SE structural corridor (Chaska-Rumichaca) located ~30km eastwards from Cerro de Pasco. Whose boundaries are regional faults that determine a paleozoic block belonging to the Marañon Metamorphic Complex (MMC). The western boundary (Rumichaca Fault) corresponds to a SW verging reverse fault that outcrops within the MMC; whereas the eastern boundary (Chaska Fault) is a compressional shear zone with NE vergence that puts the MMC over the folded Mitu (upper Permian-lower Triassic) and Pucara (upper Triassic-lower Jurassic) Groups. This boundary shows a flexure from NW-SE to N-S azimuth which is associated to subordinate compressional, extensional and strike-slip faults. Besides, its orientation has spatial correlation with maximum anomalies of Zn (~3-13%), Ag (~450ppm) and Pb (~4-19%) that were checked out into the Pucara-Mitu Groups as well as around dacitic-granitic intrusions.

RESUMEN
Tectónica de una zona de cizalla ligada a mineralización polimetálica por Zn-Ag-Pb: El Proyecto Pasco, Perú

Entre Huachón y Corralcancha (Cordillera Oriental) se ha identificado un corredor estructural NO-SE (Chaska-Rumichaca) ubicado a ~30km al este de Cerro de Pasco. Cuyos límites son fallas regionales que determinan un bloque paleozoico del Complejo Metamórfico del Marañón (CMM). El límite occidental (Falla Rumichaca) corresponde a una falla inversa de vergencia SO que aflora dentro del CMM; mientras que el límite oriental (Falla Chaska) es una zona de cizalla compresional de vergencia NE que coloca al CMM sobre los Grupos Mitu (Pérmico superior-Triásico inferior) y Pucará (Triásico superior-Jurásico inferior) replegados. Este límite exhibe un flexionamiento de NO-SE a N-S que está asociado a fallas subordinadas de cinemática compresional, extensional y de desgarre. Además, su orientación tiene correlación espacial con anomalías máximas de Zn (~3-13%), Ag (~450ppm) y Pb (~4-19%) verificadas en los Grupos Pucará-Mitu y en bordes de intrusión dacítica-granítica.

KEYWORDS:
Structural corridor Chaska-Rumichaca, cenozoic tectonics.

1. Introduction

Within the Pasco and the southern Huanuco departments for the central Peru, there are a variety of polymetallic occurrences such as Cerro de Pasco (Zn-Pb-Cu-Ag), San Miguel (Ag-Pb-Zn), Milpo (Zn-Cu-Pb), Atacocha (Pb-Cu-Zn-Ag) and Shalipayco (Zn-Pb-Ag) mines. Some of them are hosted in paleozoic sedimentary units that contain miocene intrusions (Baumgartner, 2007). And some other lie into mesozoic sedimentary units from the Marañon Fold-Thrust Belt which bears Oligocene-Miocene intrusions (Soler y Bonhomme, 1988; Bissig et al., 2008). Nevertheless, towards the NE of this region, along Huachon and Corralcancha (Eastern Cordillera) it also outcrops a more restricted folded fringe of sedimentary rocks from Mitu (upper Permian-Lower Triassic) and Pucara (upper Triassic-Lower Jurassic) Groups. Here, GPM Metals Peru is developing the “Pasco Project”. Whose first stages of study have estimated a new geological mapping with the goal of defining its tectonic array and getting a relationship with mineralization. Essentially, by means of sampling through rock chip channels and soils. What they were also taken for analysis of X-Ray fluorescence (XRF).

2. Location

Project Pasco is located ~30km eastwards from the Cerro de Pasco city, ~3km NW from Huachon and ~30km SE from Corralcancha with a surface of 5500ha (Fig. 1).

2.1. Geological field mapping

2.1.1. Sedimentary and volcanic stratigraphy

Paleozoic-Mesozoic and Mesozoic-Cenozoic rocks are separated by angular unconformities. So, it has three major divisions. (1) Paleozoic: Phyllites from the Marañon Metamorphic Complex (MMC) of Neoproterozoic-Carboniferous age. (2) Mesozoic: Volcanogenic sandstones, conglomerates and rhyolic ignimbrites from Mitu Group (upper Permian-Lower Triassic) in concordance below mudstone and grainstone limestones from the Pucara Group (upper Triassic-Lower Jurassic). (3) Cenozoic: Whose stratigraphy has been recognized for first time and are named arbitrarily: Cushurpata subvolcanic andesites below Tarata ignimbrites and both of them underlie through angular unconformity to Milpo ignimbrites. Since it does not exist any radiometric ages for this last division, the first ones are roughly from the Paleogene; whereas the overlying Milpo ignimbrites, at least they must be between the Paleogene-Neogene.

2.1.2. Tectonic array

It is represented by three structures. The first is a reverse fault called in this work as the Rumichaca Fault that has a length of ~10km with a NW-SE to N-S azimuth and SW vergence that affects to the MMC by tight folding of short amplitude. The second, is another reverse fault: The Chaska Fault (~8km, NO-SE a N-S) with a NE vergence and puts MMC over the folded Mitu and Pucara Groups at the heart of Pasco Project (syncline from the quebrada Milpo). ~5km eastwards from Corralcancha, the Chaska Fault becomes the Corralcancha Fault (~12km, N-S) where it is accompanied by ~N-S dextral faults and local tensional structures of anti-Andean azimuth (NE-SW). All of these reverse faults bear other accessory oblique thrusts (≤1.5km), their geometry is en echelon with NE vergence. By this, in some sites the stratigraphic levels of Mitu Group are repeated. The third structure corresponds to the normal fault “Chipa” (≤3.5km, NO-SE) which is SW dipping and makes the hanging-wall of Pucara Group lies in sharp contact with the folded Mitu Group.

2.1.3. Intrusive rocks

In previous studies (Cooperación Técnica Japonesa-INGEMMET, 1979; Zapata et al., 2003) had already reported the paleozoic granites “Paucartambo-Ayancocha”. Though, it is posible to observe up to six lithologies of different ages: Carboniferous-Permian granites just cut the MMC, being dated at the southern Huachon and the northern Corralcancha through U/Pb in 309,4Ma (Miskovic et al., 2009) and 291,3Ma by K/Ar in (Cardona, 2006), respectively. Then, there are the Permian-Triassic tonalites that only cut the MMC and Mitu Group. The Pucara Group is intruded by upper Triassic-upper Jurassic tonalites that are in dated 202 and 151Ma (K/Ar) at the northeastern Huachon area (Soler, 1991). It also exist granites and diorites of pos-mesozoic age that appear as intrusions over the traces of Chaska and Rumichaca Faults. As well as, ”Tarata” dacites outcrop 2km northwards from the Pasco Project whose orientation is NW-SE but their age is certainly unknown. Yet, due to they cut Cushurpata andesites and Tarata ignimbrites, such dacites are roughly coeval with the pos-mesozoic intrusions and previous to the instauration of the Milpo ignimbrites.

2.2. Rock chip channel and soil sampling

~600m in NE direction from the Chaska Fault, at the syncline of the quebrada Milpo (Fig. 2), it has been taken 231 limestone samples in 40 channels of 10m, 20m, 50m, 75m with total length of 1105m that mainly show values of Zn (200-12400ppm), Ag (2-213ppm) and Pb (1-2%). There are channels of 75m that have @9.4ppm of Ag; as well as rocks seen in galleries with the following values: 13.3% (Zn), 19.15% (Pb) and 466ppm (Ag). The XRF analysis for 2564 samples in an area of 4.25kmx1km for a such limestones, are indicating values of Zn among 1000 and 27645ppm with peaks of 3% within the deformation core. Where there are also intermediate ranges (50-100ppm) and other gently lower values nigh the contact with the Mitu Group (<50ppm). Furthermore, limestones have mineralization by galena. Their Ag anomalies are between 20 to 152ppm with direct correlation with Pb anomalies (100-39751ppm with peaks of 4%). At the eastern sector of the Corralcancha Fault, the syenogranites/granites Paucartambo-

Ayancocha nearly lie in contact with the Mitu Group. Intrusion edges have anomalies of Zn, Ag and Pb (500-700ppm).

3. Results

Among the most important regional faults, it has identified the “Chaska-Rumichaca” structural corridor which has NW-SE orientation. Its eastern boundary (Chaska Fault) turns out to be a compressional shear zone and partially dominated by strike-slip movements. Each movement in the tectonic array influenced in the generation of newer faults (especially local structures), likewise it had to do with the partial and/or whole kynematic change at the inner surface of preexisting faults.

4. Discussion

Tectonics from the study area is analogue to the partitioning models of deformation (Fossen y Tikoff, 1998; Waldron, 2005); yet it cannot fully compare with them since the fault movements occurred in different times. In spite of this, it adjusts with the tectonic inversion of the proto-Andes during the upper Cretaceous-Paleogene (Mégard, 1987). One argument in favor of this corresponds to the resemblance of Chaska-Rumichaca structural style with the regional folding of the Cerro de Pasco quadrangle that is affected by cenozoic intrusions (Rodríguez et al., 2011). For instance, this kind of processes are reported in the Pucara Group limestones that are intruded by diorites and granites at the eastern edge of the Pasco-Ayacucho Fault in the Jauja quadrangle (Paredes, 1994). The same goes for the granitic intrusions over the limestones of Pucara Formation/Jumasha Formation at the surroundings of Cercapuquio for the Huancayo quadrangle (Mégard, 1968).

5. Conclusions

For the Pasco Project, the cenozoic tectonics was associated to intrusion pulses that replaced limestones of Grupo Pucara. Therefore, it does not only exist a lithological control, but there is also a structural one characterized by the Chaska Fault (chiefly compressional) which gave birth to areas dominated in transpression and transtension. Whose deformation triggered the occurrence of mineralization by Zn-Ag-Pb at the margins of the kilometric faults revealed in this work.

6. References

Baumgartner, R., 2007, Sources and evolution in space and time of hydrothermal fluids at the Cerro de Pasco cordilleran base metal deposit, Central Peru. PhD. Tesis, Suiza, Universite De Genève, 167p.

Bissig, T., Ullrich, T., Tosdal, R.M., Friedman, R.M., Ebert, S.W., 2008, The time-space distribution of Eocene to Miocene magmatism in the central Peruvian polymetallic province and its metallogenetic implications. Journal of South American Earth Sciences, v. 26, p. 16-35.

Cardona, A., 2006, Reconhecimiento da evolucao Tectonica da Proto-Margen Andina do Centro-Norte Peruano, baseada em dados Geoquimicos e isotopicos do Embasamento da Cordilheira Oriental na Regao de Huanuco-La Union, Programa de Pos-Graduação em Geoquimica e Geotectônica. PhD Tesis, Brasil, Universidad Sao Paulo, 198p.

Cooperación Técnica Japonesa-INGEMMET, 1979, Mapa geológico del cuadrángulo de Ulcumayo (22l), escala 1/100,000. INGEMMET. Carta Geológica del Perú.

Fossen, H., and Tikoff, B., 1998, Extended models of transpression and transtension, and application to tectonic settings, in Holdsworth, R. E., Strachan, R. A. and Dewey, J. E., eds., 1998. Continental Transpressional and Transtensional Tectonics. Geological Society, London, Special Publications, 135, p. 15-33.

Mégard, F., 1968, Geología del cuadrángulo de Huancayo: INGEMMET. Boletín, Serie A: Carta Geológica Nacional, Nº18, 120p.

Mégard, F., 1987, Structure and evolution of the Peruvian Andes, in Schaer, J.P., Rodgers, J., eds., The Anatomy of Mountain Ranges. Princeton, University Press, p. 179-210.

Mišković, A., Spikings, R.A., Chew, D.M., Košler, J., Ulianov, A., Schaltegger, U., 2009, Tectonomagmatic evolution of Western Amazonia: Geochemical characterization and zircon U-Pb geochronologic constraints from the Peruvian Eastern Cordilleran granitoids. Geological Society of America Bulletin, v. 121, p. 1298-1324.

Paredes, J., 1994, Geología del cuadrángulo de Jauja: INGEMMET. Boletín, Serie A: Carta Geológica Nacional, Nº 48, 106p.

Rodríguez, R., Cueva, E., Carlotto, V., 2011, Geología del cuadrángulo de Cerro de Pasco: INGEMMET. Boletín, Serie A: Carta Geológica Nacional, Nº144, 160p.

Soler, P., 1991, Contribution à l’etude du magmatisme associe aux marges actives-petrographie, geochimie et geochimie isotopique du magmatisme cretace a Pliocène le long d’une transversale des Andes du Perou Central-Implications geodynamiques et metallogeniques. PhD. Tesis, France, Universite Pierre Et Marie Curie Paris, 846p.

Soler, P., and Bonhomme, M.G., 1988, Oligocene magmatic activity and associated mineralization in the polymetallic belt of central Peru. Economic Geology, v. 83, n. 3, p. 657-663.

Waldron, J.W.F., 2005, Extensional fault arrays in strike-slip and transtension. Journal of Structural Geology, n. 27, 23-34.

Zapata, A., Rossell, W., Abarca, F., 2003, Actualización del mapa geológico del cuadrángulo de Ambo (21k), escala 1/100,000. INGEMMET. Carta Geológica del Perú.

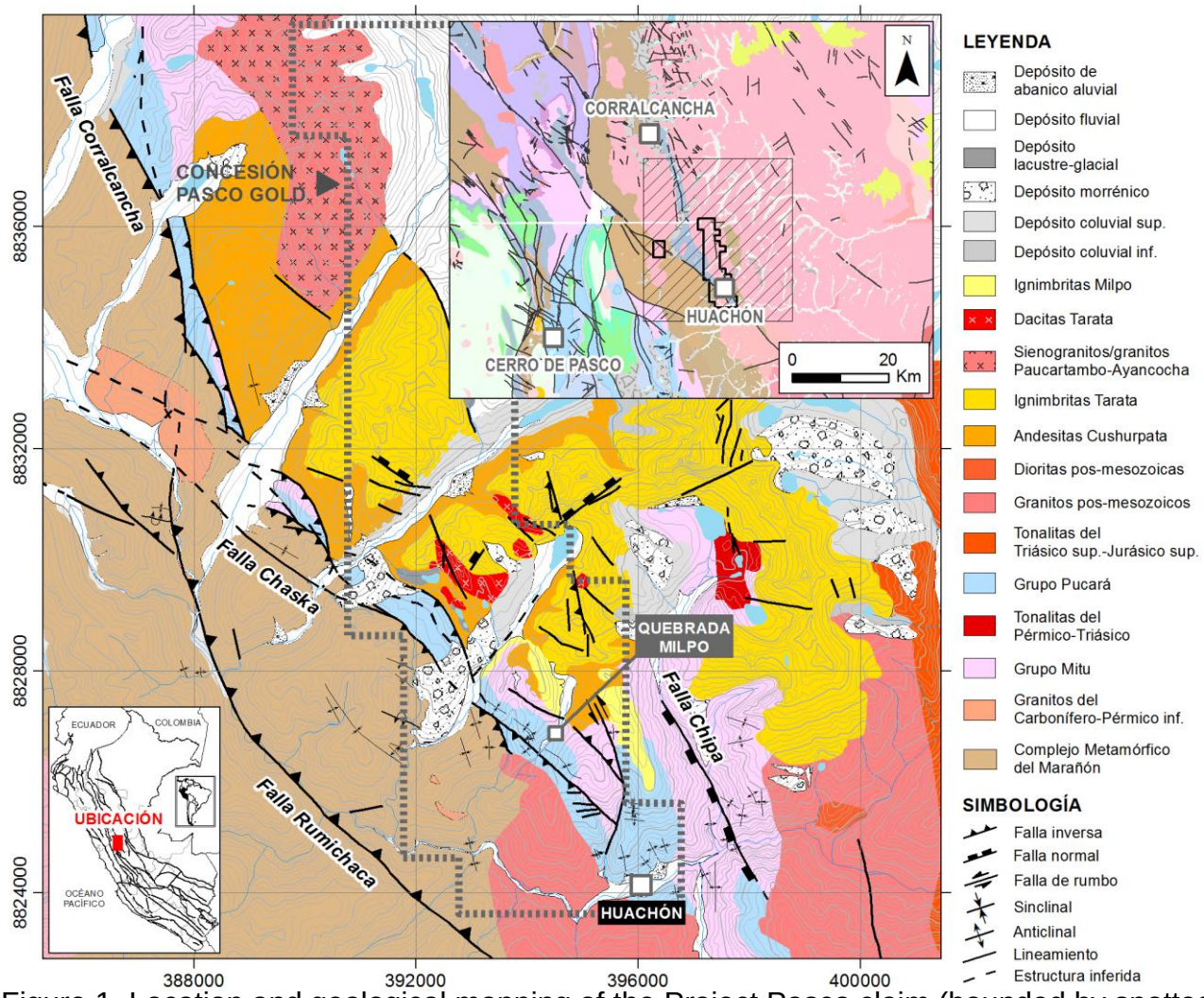

Figure 1. Location and geological mapping of the Project Pasco claim (bounded by spotted lines).

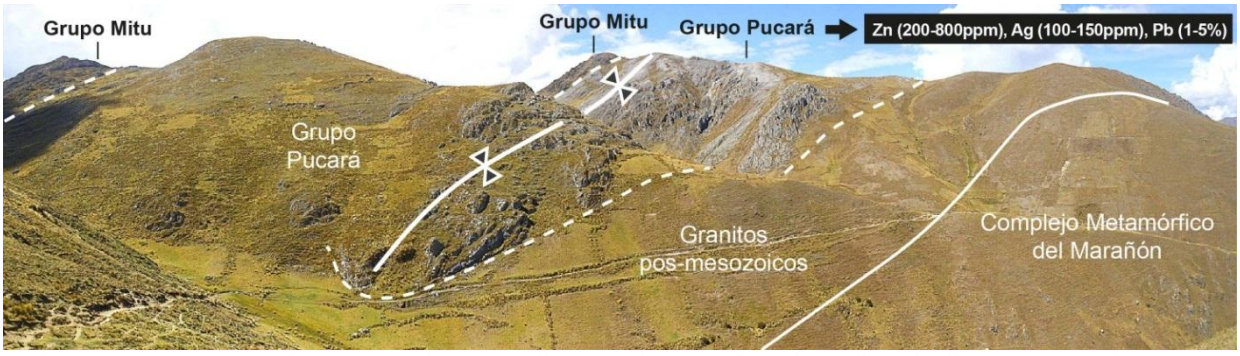

Figure 2. NE-SW view from the syncline of the quebrada Milpo in limestones (Pucara Group). One of the best anomalies, exposed into the black rectangle, is present within such limestones near to the deformation core (grayish outcrops).