Structural setting and metal zoning of the Ag-Au veins of the Real de Minas de Zacualpan District, Central Mexico

Brian V. Hall, George A. Gorzynski, Nigel J. Hulme, Alberto R. Villa-Sánchez, Roberto Díaz-Martínez, Carlos Cham-Dominguez, Federico Limón Gallegos and Jose Luis Aldana

The Real de Minas de Zacualpan (Royar Mines of Zacualpan) District, located 100 km southwest of Mexico City is arguably the site of the oldest known mining activity in North America, predating the arrival of Hernan Cortez in 1519, and second only to the Dominican Republic and Tacoo, Mexico in terms of modern mining (mining using explosives) in the Americas.

During the past seven years IMPACT Silver Corp. has been engaged in an aggressive exploration program, which has included the compilation of roughly 500 years of mining activity into a GIS database. Using the computer program ArcGIS 10.1 geological mapping and geochemical samples (>25,000) on some 1,900 veins, of which 792 contain elevated values for silver (>100 g/t) and gold (>0.5 g/t) have been imputed. As well over 3,100 old mine and exploration workings have been located.

The 423 km² Zacualpan District is represented by an 18 km wide structural corridor of dextral transpressional shear, hosted in the Guerrero Terrane, in which andesitic volcanic rocks of the Vila de Ayala Formation act as a rigid block resulting in brittle deformation represented by faulting and fracturing. Felsic intrusive rocks of the Tilzapolta Formation, located midway between the Zacualpan and Taxco (located 27 km to the southeast) Districts appears to have acted as a point heat source that has focused the flow of the hydrothermal solutions. The age of the veins for the Taxco District range from 30-32 Ma (Pl. T. et al, 2005), and by analogy the Zacualpan veins are presumed similar, with the age of the Tilzapolta Formation at 32 Ma (Alvarez, S.A. et al 2002).

Important structural features include: 1) a series of northeast dipping dextral structures which often host veins that are tens of kilometers long, 2) south-southwest dilational jog features, that have a vertical sense of displacement and are bounded by the northeast dipping dextral structures, 3) northeast dipping veins having a dextral sense of movement that appear to represent splays from the northeast dipping veins, 4) numerous smaller splay and transverse veins that are associated with both the northeast and southwest dipping dextral structures, and 5) an enigmatic series of north to southeast striking veins located in the central portion of the district that appears to have the overall structure of a horst.

The district is zoned and tilted with Mesothermal Au-Cu-Ag veins occurring to the southwest and Epithermal Ag-Pb-Sb veins in the northeast. Other factors controlling geochemistry of the veins are: 1) higher gold contents in proximity to felsic intrusives of the Tilza, 2) higher gold values in local extensional structures, 3) a blue to higher gold values for the dilational jog structures, which again represent extensional structures, 4) depth of emplacement, and 5) topography.

Utilizing the data handling and analysis methods developed by IMPACT Silver Corp. a drilling success rate in excess of 60% in terms of intersecting economically significant veins has been achieved, which has resulted in the discovery and commissioning of five mines within the past six years.

In 2009 Impact Silver announced the successful launch of the GIS Database using the computer program ArcGIS. One aspect of this Database is the documentation of 3,092 Historical Mine Workings, which continues to grow with the addition of ten each week. It has been found that the most cost effective manner to find and document the silver-gold veins is to first locate the old workings, many of which date back to the Spanish Colonial times. The larger workings (120) generally indicate areas of historic production, whereas the smaller workings can be used to trace the veins such that detailed mapping and sampling can be conducted. In order to systematically explore a 623 square kilometer property that is as richly endowed as the Zacualpan District, smaller areas are prioritized for detailed prospecting and geological mapping (Fig. 4a) and subsequent drilling. Representing the black squares in Fig. 4b is a detailed subset centered over the Nochebuena- Carlos Pacheco Area (Fig. 4d) which clearly

The soil geochemistry for silver and gold exhibit many of the same patterns, which in turn represent some of the more prominent veins, with silver being stronger in the northeast (Fig. 6a) and gold in the central portion (Fig. 6b). As well for arsenic (Fig. 6c), copper (Fig. 6d) and manganese (Fig. 6e) a pronounced progression going from the central portion of the soil grid to the northeast is evident. This is interpreted in terms of the Zacualpan District having a northeast dip or tilt, with the deeper portions of the veins exposed in the center, and the uppermost and silver rich portions exposed in the northeast corner.
When constructing the Vein Interpretation Map, each vein is digitized into "vein segments" (Step 3) which represent those portions on which rock samples have been collected for chemical analysis, and precise structural information concerning the vein's orientation have been measured by geologists in the field.

Step 4 shows the rock sample assay information, in which various sized triangles represent differing silver contents. Combining the Vein Interpretation Map of Step 3 for the vein segments with the rock sample geochemical data from the Rock Sample Database (Step 4), produces the map in Step 5, which in this case represents the Gold/Silver ratios.

Shown in Fig 8 is the detailed area of Step 5 in Fig 7. This area attains the highest gold / silver ratios, and when viewed in terms of the geological mapping it is only in this specific area that felsic volcanic rocks of the Oligocene Tilzapolta Formation outcrop, again suggesting this rock type likely represents a heat source for the hydrothermal solutions.

The Nochebuena Vein and Carlos Pacheco Veins are subparallel structures, both occupying normal faults and occur only 180 meters apart. The metal content for the Carlos Pacheco Vein is dominated by gold-copper, whereas the Nochebuena Vein is silver rich. Once the offset for the faults are reconstructed using the stratigraphy, 560 meters of pre-mineralization offset is evident.

The Vein Segment Map for Silver (Fig 11a) indicates the best silver grades are found in the northeast near the town of Zacualpan and predominately within the north-westerly striking veins. Gold (Fig 11b) and Copper (Fig 11d) on the other hand tend to be more abundant in the northerly striking veins and at lower elevations.

Geologists have often been accused of producing a plethora of maps to express a concept, whereas management would prefer one simple map that nicely summarizes where the best targets are, and ranks them in order of economic significance.

Management here is your one map!!

Since the Zacualpan District can best be described as polymetallic, with silver, gold, lead and zinc contributing it was decided to go to an "in ground metal content" to provide a consistent datum for determining the value of a vein.

On this map the vein segments have symbolized according to the "in ground metal values" according to the rock sample database, which in turn have then been multiplied by the width of the veins, and coloured according to importance. For reference some of the drilled deposits are shown in the light orange boxes, with our more promising prospects show in the purple boxes. In the case of La Soledad and Tapachichi the process of digitizing the vein segments has only just commenced, and geological mapping is ongoing, hence the relatively small size for these vein areas.