**RESISTIVITY ELECTRICAL IMAGING STUDY OF THE RIO TINTO MARS ANALOG: EVIDENCES FOR A FAULT-CONTROLLED DRAINAGE PATTERN.** D. Gómez-Ortiz[1], D. C. Fernández-Remolar[2], O. Prieto-Ballesteros[2], F. Gómez[2]. [1]ESCET-Área de Geología, Universidad Rey Juan Carlos, 28933 Móstoles, Madrid, Spain (david.gomez@urjc.es), [2]Centro de Astrobiología-INTA, 28850 Torrejón de Ardoz. Spain (fernandezrd@inta.es, prietobo@inta.es, gomezgf@inta.es).

**Introduction:** The Rio Tinto Mars analog belongs to a an acid volcano-sedimentary complex, ranging in age from upper Devonian to Carboniferous, called theThe Iberian Pyritic Belt (IPB) [1, 2]. Inside the IPB, the Rio Tinto area contains some of the largest world's massive sulfide deposits.

The interaction between groundwater and sulfide deposits and sulfide-free rocks provides geochemical processes controlling the geochemistry of both surface fluids and groundwater. The resulting waters are characterized by an acidic chemistry (pH mean value of 2.3), and high concentrations of sulfur and iron in solution, which control the formation of analogous mineral associations that have been recognized in Meridiani [3, 4, 5].

It has been previously proposed [6,7] that the fracture pattern in Peña de Hierro aquifer controls the headwaters that supply the acidic waters of Río Tinto. In this study, electrical Resistivty Imaging (ERI) technique has been used to prove that the acidic springs or Rio Tinto area are controlled by sub-vertical faults allowing the flow of both the surface and subsurface acidic waters.

**Geological setting:** Peña de Hierro is located at the contact between two different tectonic units included inside the IPB, Concepcion Unit to the North and RioTinto-Nerva Unit to the South (Fig. 1). The first one is composed by shales acidic tuffs and volcanic materials. The second one is composed of dark shales and greywackes. A highly deformed thin unit of purple shales delineates the contact between both units, defined by the San Miguel-Minas del Castillo Shear Zone (SMCSZ). It corresponds to a 55-km long Shear Zone with a N110ºE trend and dipping 70º N. The SMCSZ formed during the second phase of deformation associated to the Variscan Orogeny (Fig. 1) and corresponds to a transpressional ductile deformation with associated penetrative foliation [1, 2].

A Late-Variscan episode of deformation is responsible for the development of a conjugate strike-slip system of brittle fractures trending NNW-SSE (dextral) and NNE-SSW (sinistral) respectively. These fractures are extensively distributed all around the IPB and represents the transition form ductile transpressional deformation to a brittle transtensional event related to the collapse of the Variscan Orogen.

The tectonic framework of Peña de Hierro aquifer has been analysed using satellite imaginery analysis and artifical shading of a Digital Elevation Model [6]

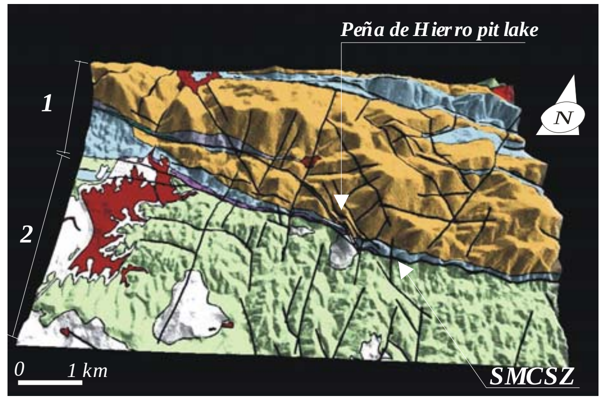


**Figure 1**. Geological map of the study area. 1: Concepcion Unit. 2: Rio Tinto Nerva Unit. The contact between both tectonic units corresponds to the San Miguel-Minas del Castillo Shear Zone (SMCSZ). The lineaments mapped, corresponding to the fracture patern, are shown in black.

Three different orientations have been outlined: ESE-WNW, NNE-SSW and NNW-SSE. The three fault systems clearly control the drainage pattern in the area. It has also been proposed [6] as the mechanism that recharge the Peña de Hierro aquifer from rainwater and that control the under ground water fluxes.

**Geophysical survey:** In order to confirm the control of the fault pattern on the surface and subsurface water flows, a geophysical survey using ERI technique has been carried out at the Peña de Hierro and surrounding areas.

Several standard electrode arrays are available, with different horizontal and vertical resolution, penetration depth and signal-to-noise ratio. The dipole-dipole array gives good horizontal resolution but may have a poor signal-to-noise ratio because the potential electrodes are outside of the current electrodes. The Wenner array is usually applied for a good vertical resolution, but may also provide a reasonable horizontal resolution [8]. This method has greater signal-to-noise ratio than the dipole-dipole method because the potential electrodes are placed between the two current electrodes. In order to combine the benefits derived from the standard electrode arrays and/or different electrode spacings in some field profiles, both of them were obtained independently, and then combined in a mixed array that has been jointly inverted and interpreted.

The resistivity profiles were carried out at two acidic springs belonging to the origin of the rio Tinto river, and on the location of a borehole used for sampling and monitoring of the acidic waters. From a general point of view, three resistivity units are definid: very high resistivities corresponding to colluvium deposits on the surface, high to moderate resistivity units related to fresh and weathered shales respectively, and a low resistivity unit associated to recharge areas in the shales (Fig. 2). The sharp vertical or subvertical contacts between some of the aforementioned units, can be easily explained by considering subvertical fracture zones affecting the shales. The location of these fratures always corresponds to the presence of the acidic springs and/or surface waterflows, confirming the tectonic control that the fracture pattern exerts on the acidic water flows.

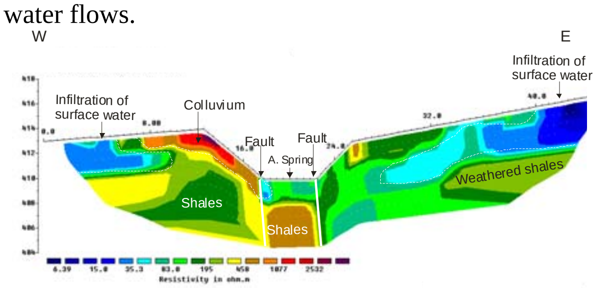


**Figure 2**. Resistivity profile transverse to one acidic spring belonging to the headwaters of Rio Tinto river. Sharp vertical gradients limiting units with different resistivity are interpreted as subvertical fractures that control the drainge network. The occurrence of surface recharge areas is also shown.

**Implications for Mars undeground water fluxes:** Fractures affecting to the Mars volcanic basement have probably played an essential role in storaging and transporting underground fluids through physicochemical grandients controlled by pH changes and oxidant concentration. In this sense, the Rio Tinto subsurface research provides some insights to understand the physical and chemical behaviour of the Martian aquifers providing clues to explain the formation of sulfur bearing compounds observed in Meridiani and many other regions of Mars. The resistivity method could be very appropriate to detect and characterize fractures at the Martian surface that can play an important role in the storage and flow of subsurface water. The method has provided good results in the Rio Tinto Mars analog and similar results could be obtained in the Martian aquifers.

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