Exhumed geothermal systems as the key for understanding active geothermal fields: The case of Las Minas (Mexico)

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ABSTRACT

The migration and storage of geothermal fluids is one of the most fascinating and important tasks during the exploration of the geothermal resources, since, generally, the geothermal fluids are channelled through fault zones, thus turning fault zones into a critical point to study. However, these fluids, being highly saline tend to seal these structures, determining hydrothermal minerals deposits when the conditions of P-T are suitable. Therefore the analysis of exhumed mineral deposits helps to understand how the geothermal fluid flow occurred, being now fossilized in form of hydrothermal veins and skarn. The fossil systems in fact allow us to study at surface what in active geothermal fields is currently occurring to depth and thus favouring the understanding of the most feasible way to exploit geothermal resources. Another important value derives from the study of those exhumed geothermal system considered as proxies of nearby active systems. In these cases, the results from the study of the relationships between fractures and mineralization can be transferred to the deep part of the active geothermal system (Fig.1).

In the locality of Las Minas, Veracruz (Mexico) is found an exhumed geothermal system which is considered a proxy of the active geothermal field of Los Humeros (94 MWe of installed capacity) because they have very similar geological setting and have been suffering the same volcano-tectonic evolution since middle Miocene. The lithological sequence of the Las Minas zone was determined, with novelties with respect to the previous maps, generating a new geological map to the scale 1:20 000. In this area an intrusive body (batholitic dimension) of composition, ranging from quarzodioritic to tonalite, was found, which intruded an upper Cretaceous limestone and marl.

During intrusive cooling, fractures and pre-existing foliations channelled fluids producing skarns within the calcareous sediments, along fractures and bedding, in relation to their proximity to the intrusive; the skarn is classified as pyroxene and garnet skarn, both with important quantities of metallic minerals as pyrite, chalcopyrite, hematite, magnetite and sphalerite.

Two main SW-NE and NNW-SSE striking fault systems were recognized. The SW-NE striking system displays a dominant normal component while the NNW-SSE system is characterized by two movements, the first, dominantly oblique and the second mainly normal. These kinematics, together with their geometric relationships account for an extensional setting with normal and transfer faults, contemporaneously active.

The interplay between the two fault systems led to the formation of a tectonic basin where lacustrine, lahar and volcano-sedimentary deposits accumulated. It is also important to note that an important pre-, syn- and post-sedimentary tectonic activity was found within the lacustrine deposit that gave rise to the formation of sismites, slumps and their related tilting. Then, these two fault systems were controlling Miocene dykes implying a permeability active from that time.

Concluding, by this structural and kinematic survey carried out in the area, the main structures of the study area were determined. The different kinematics allows us to suggest a possible path for fluid migration, based on the orientation of the intermediate kinematic axis (indicating the most favourable path for fluid flow). This results almost vertical in the NNW-SSE structures, thus allowing the movement of deep fluids to shallow levels; differently, it is from horizontal to oblique in the SW-NE structures, thus permitting the lateral migration of fluids, when such a structures are hydraulically connected to the NNW-SSE fault zones.

A similar structural setting is therefore envisaged for the deep part of the Los Humeros field, targeted for future exploitation.

The importance of this study is in its novelty, proposing a new approach for the area and the possible fallouts for the geothermal exploitation in Los Humeros area, where the drilling deep wells have a large unsuccessful percentage (almost 50%).

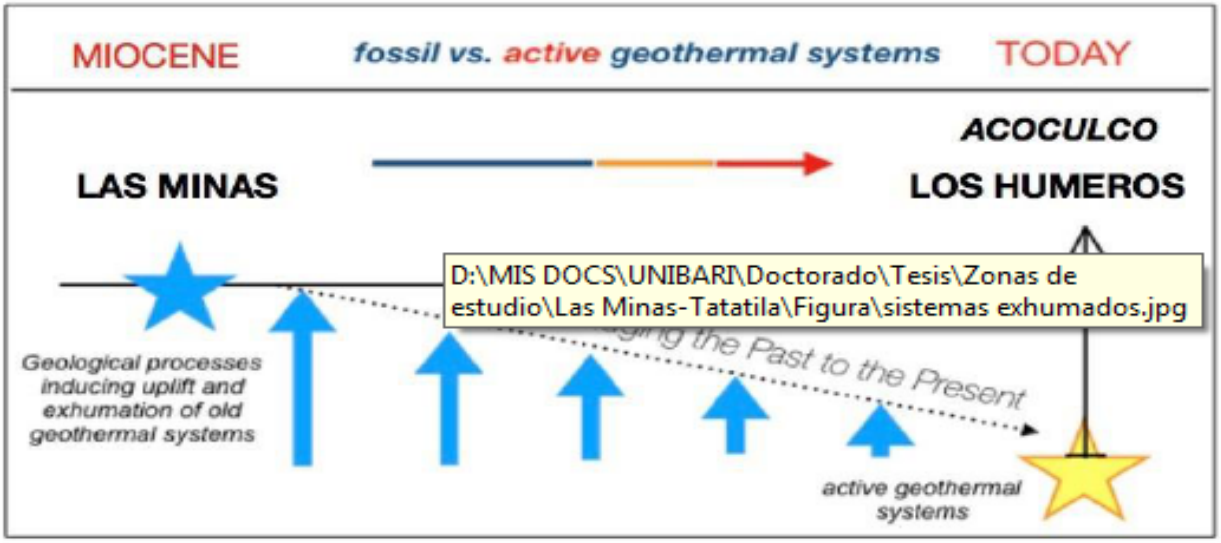

Fig 1. Geological schema that exemplifies how exhumation processes carry deep structural levels to the surface which can be studied directly to understand what happens in active systems considered proxies.

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