

Palaeozoic magmatic-related hydrothermal activity in the Almadén syncline, Spain: a long-lasting Silurian to Devonian process?

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Almadén (central Spain) is the most remarkable mercury-mining district in the world, having produced one-third of the total world output of this element. The mercury orebodies are hosted by sedimentary and volcanic rocks belonging to a Lower Palaeozoic sequence that unconformably overlies the pre-Ordovician basement of the Central Zone of the Iberian Variscan Chain^{2,3} (Fig. 1). The Almadén rocks and mineralization pose an intriguing problem because in addition to the classic Lower Silurian strata-bound mineralization (e.g. Almadén and El Entredicho) other deposits are found higher in the stratigraphic sequence in both Silurian and Devonian

been carried out in conjunction with re-evaluation of the already available isotopic and stratigraphic data in the hope of providing new insights into the genetic environment in which the alteration and mineralization processes took place. It is suggested that the persistent submarine magmatic activity in the Almadén basin may have sustained long-lasting submarine hydrothermal activity through most of the Silurian and Devonian, i.e. a time-span of about 70 m.y.

Geology, mineralization and alteration processes

The Almadén volcanic-sedimentary rocks range from Lower Ordovician to Upper Devonian in age. They comprise several sequences of black shale and sandstone/quartzite units with frequent intercalations of submarine mafic alkaline volcanic rocks^{2,3} (Fig. 1). Geophysical data⁹ and surface mapping show that the mafic volcanism within the Almadén syncline was far more important than elsewhere in the region. The magmatic record is almost continuous and evolved from early, widespread basanitic/nephelinitic and alkali-olivine basaltic volcanism, mostly into the Silurian-Devonian part of the section, to late transitional/tholeiitic intrusive dolerites, which are scattered throughout the whole sequence.^{2,3} These rocks are pervasively transformed to albite-chlorite-carbonate-rich spilites.^{2,3} The whole sequence was folded, weakly metamorphosed and intruded by felsic plutonic rocks during the Variscan deformation.³

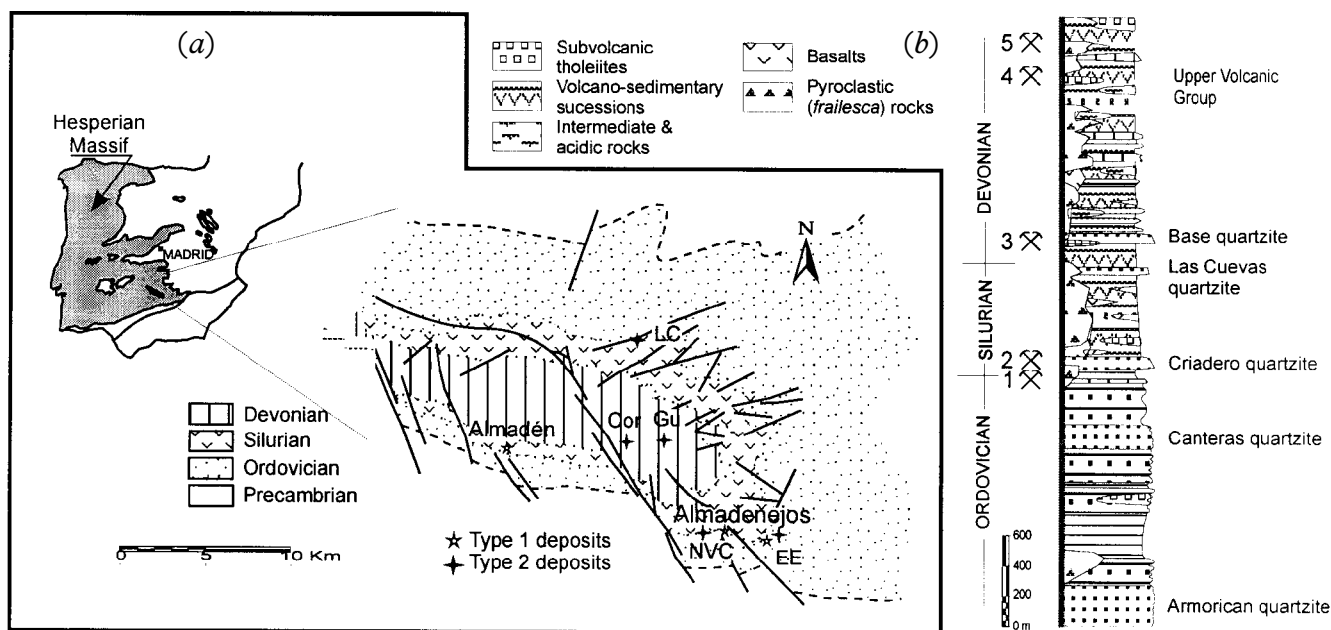


Fig. 1 (a) Geological map and (b) stratigraphic column of Almadén syncline showing locations of selected Hg deposit and samples (modified after Higuera³). Cor, Corchuelo (4); EE, El Entredicho (1); Gu, Guadalperal (5); LC, Las Cuevas (3); NVC, Nueva (2); and Vieja Concepción (1). Numbers in brackets refer to position of deposits in stratigraphic column (b)

rocks³ (Fig. 1). Furthermore, throughout the stratigraphic column the volcanic rocks are pervasively transformed to albite-chlorite-carbonate-rich spilites, i.e. the effects of the so-called regional alteration.²⁻⁴

A preliminary investigation of strontium isotopic compositions in different hydrothermal alteration assemblages has

The mercury deposits are classified into two main types on the basis of their structural setting, host rocks and hydrothermal alteration. Type 1 deposits are the largest and include those of Almadén and El Entredicho (Fig. 1). These are hosted by the Criadero quartzite and are restricted to this single stratigraphic unit at the base of the Silurian. The associated hydrothermal alteration is typified by the extensive development of Ca-Mg-Fe carbonates, chlorite and microcrystalline quartz as well as Cr-rich mica (fuchsite) in ultramafic xenoliths—a mineral assemblage defined as the regional alteration.²⁻⁴ The effects of the regional alteration can be traced in the mafic volcanic rocks along the whole Silurian-Devonian section of the Almadén stratigraphic