

4–2: The iron oxide –(Cu–Au) Deposits of SW Iberia Fregenal–Burguillos–Cala District: Lat. 38°18' N, Long. 6°40' W

F. Tornos^{a*}, C. Casquet^b, L. Rodríguez Pevida^c, F. Velasco^d

^a Instituto Geológico y Minero de España, c/Azafranal 48, 37002 Salamanca, Spain

^b Rio Narcea Nickel SA, Avda. Estación 22, 06300 Zafra, Badajoz, Spain

^c Facultad de Geología. Universidad Complutense de Madrid. 28040 Madrid, Spain

^d Universidad del País Vasco, Facultad de Ciencias, Campus de Leioa, Apdo. 644. 48080 Bilbao, Spain

Producing mining district: Cala mine. Extensive exploration is taking place in the area.

Mining: Underground and open pit.

Commodities: Cu, Au, Fe.

Past production: iron production has been concentrated in 15 mines (1910 to 2003). Copper–gold production was only minor and concentrated in the Sultana mine (1903 to 1919) or as a by-product of iron ores. Equivalent Cu ores (without gold) in Abundancia Mine.

Total resources: >180 Mt @ 25 to 66%Fe and 0.11 to 0.4%Cu. Gold grades very irregular. Cu–Au ores ca. 1 Mt, 3.15%Cu, 15 g/t Au (Sultana).

Type: iron oxide-rich end-member of iron-oxide–Cu–Au mineralization (IOCG). Cu–Au-rich ores as independent veins or as Au–Cu-rich zones in iron oxide deposits (Figs. 1, 2 and 3).

Morphology and alteration: stratabound to lensoid, locally discordant. The ironstone is related with: (a) structurally controlled albite–actinolite–salite alteration; (b) albite–actinolite rocks in the contact of albitite and host limestone and shale; (c) magnetite–vonsenite replacements; (d) massive calcic and magnesian skarn in roof pendants on the granitoids. Mineralized endoskarn is uncommon. About 30% of ironstone is skarn and the remainder is related to albite–actinolite–salite replacement.

Cu–Au ores occur as: (a) Cu–(Bi–Au) quartz–ankerite veins with sericite–albite–tourmaline–carbonate alteration; (b) Cu–(Au)-rich replacements on ironstone, associated with late amphibole, quartz and carbonates; (c) quartz veins with disseminated gold in late orogenic peraluminous granite (Tornos et al., 2003).

Age of mineralization: Lower Carboniferous, 350 to 330 Ma based on U–Pb and Sm–Nd dating of ores (Casquet et al., 1998).

Ore minerals: magnetite, chalcopyrite, maldonite, native gold, bismuthinite, garnet.



Fig. 1. Banded magnetite ore with sulphides hosting boudins of actinolite–(albite) rock: Colmenar.

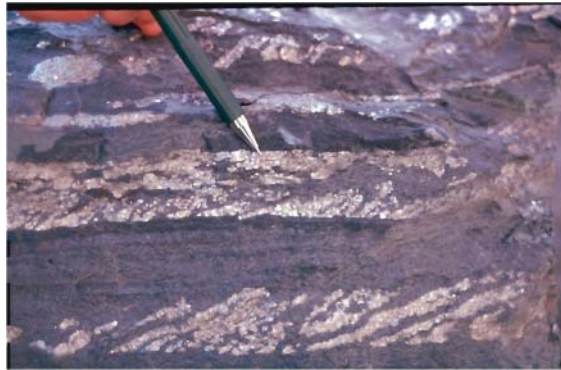


Fig. 2. Magnetite ore replaced by pyrite along tensional planes: Cala Mine.

Nature of host rocks: calc-silicate hornfels, limestone and dolostone, schist and volcanic rocks of Late Neoproterozoic to Early Cambrian age (600 to 520 Ma) adjacent to Variscan (350 to 330 Ma) quartz-diorite to granodiorite.

Isotope geochemistry of the iron ore suggests that the mineralization is a result of reaction between the Ca–Al-bearing rocks and deep hot (>500 °C) volatile (B, F, P)-rich, saline, Na–Ca–Fe fluids with heavy isotopic oxygen signatures ($\delta^{18}\text{O} = 9$ to 12‰).

This led to the formation of extensive zones of albite–actinolite–magnetite–(salite) replacement. The Cu–Au fluids are thought to have similar chemical and isotopic compositions but lower temperatures (290 to 420 °C); mineralization involved fluid unmixing or reaction with the ironstone (Tornos and Velasco, 2002). The sulphur seems to be scavenged from the host rocks ($\delta^{34}\text{S} = 11$ to 20‰). The formation of these unusual ores is interpreted as related to the intrusion at mid-crustal levels of a mafic sill during Variscan regional transpressional tectonics. Crustal delamination along the basal detachment and intrusion of the dyke produced extensive crust–magma interaction, crustal melting and widespread dehydration of sedimentary rocks. Large amounts of deep fluids and coeval metaluminous granitoids ascended along WNW–ESE to N–S crustal-scale faults, leading to the observed mineralization and related granitoids

(Tornos and Casquet, 2005).

References:

- Casquet, C., Galindo, C., Darbyshire, D.P.F., Noble, S.R., Tornos, F., 1998. Fe–U–REE mineralization at Mina Monchi, Burguillos del Cerro, Spain: age and isotope (U–Pb, Rb–Sr and Sm–Nd) constraints on the evolution of the ores. *Proceedings GAC–MAC–APGGQ Conference 98, Quebec vol. 23, p. A28.*
- Tornos, F., Casquet, C., 2005. A new scenario for related IOCG and Ni–(Cu) mineralisation: the relationship with giant mid-crustal mafic intrusion, Variscan Iberian Massif. *Terra Nova, 17, 286–290.*
- Tornos, F., Velasco, F., 2002. The Sultana orebody (Ossa Morena Zone, Spain): insights into the evolution of Cu–(Au–Bi) mesothermal mineralization. *Abstracts, GEODE Study Centre, Grenoble, pp. 25–28.*
- Tornos, F., Casquet, C., Galindo, C., 2003. Hydrothermal iron oxide–(Cu–Au) mineralization in SW Iberia: Evidence for a multiple origin. In: Eliopoulos, D.G. et al. (Eds.), *Mineral Exploration and Sustainable Development, Millpress, Rotterdam, pp. 395–398.*

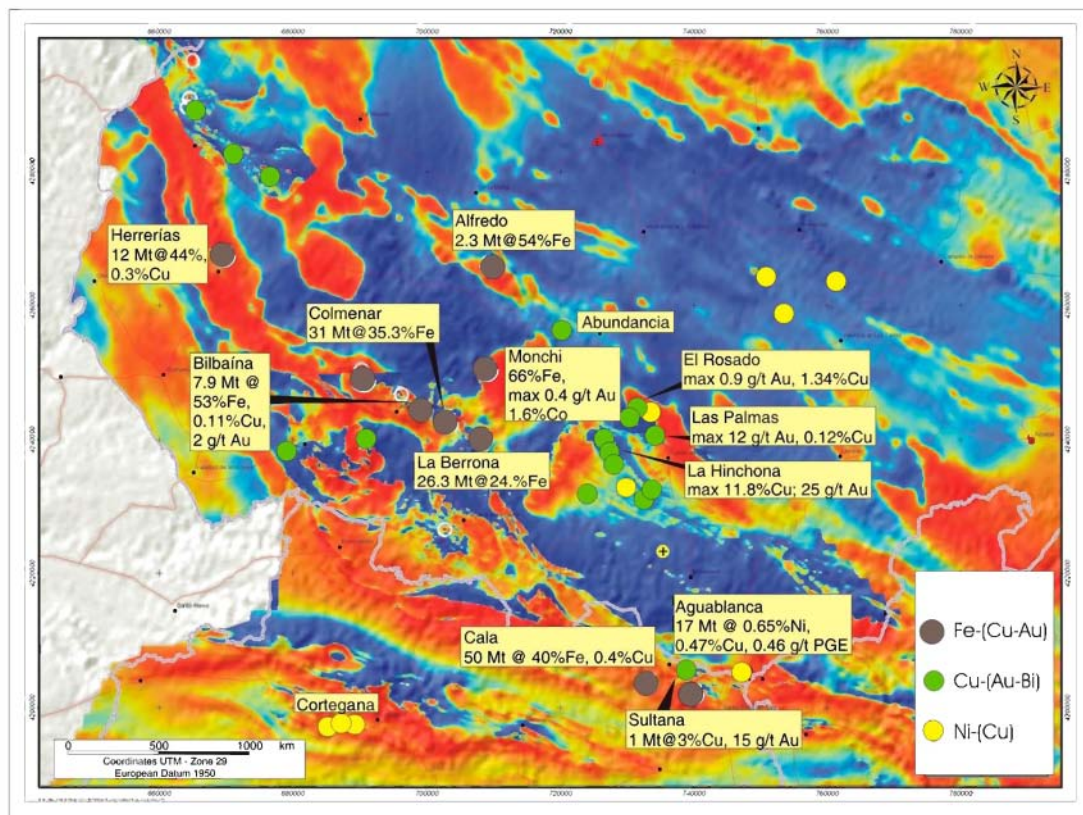


Fig. 3. Airborne magnetic map of the central Spanish Ossa Morena Zone showing the location of major iron oxide, Cu–(Au) and Ni–(Cu) mineralization.