# 4–1: The Aguablanca Ni–(Cu–PGE) deposit, SW Spain

## Ossa Morena Zone: Lat. 37°57' N, Long. 6°11' W

C. Martínez[a], F. Tornos[b]*, C. Casquet[c], C. Galindo[c]

[a] *Rio Narcea Recursos SAU, Mina de Aguablanca,41250*

[b] *Instituto Geológico y Minero de España,*

[c] *Dpt. Petrologia, Facultad de Geologia, Universidad Complutense de Madrid,*

Received 25 June 2004, accepted 27 January 2005

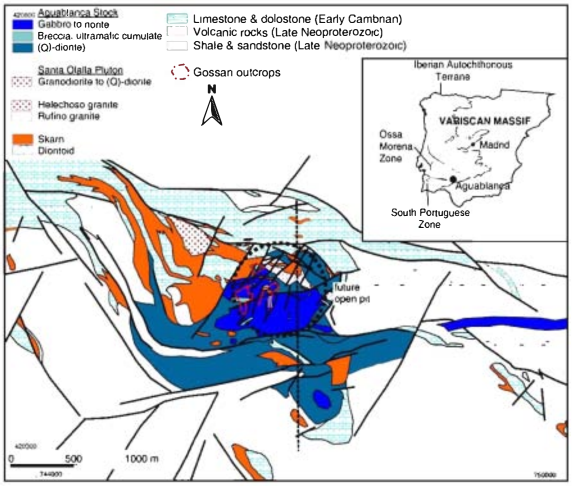



Fig. 1. Geological map of the Aguablanca orebody, modified from unpublished mapping by Rio Narcea Recursos and Tornos et al. (2001). The N–S dashed line is the projection of the section in Fig.2.

**Producing mining district:** the only known economic deposit is Aguablanca (Figs. 1 and 2), which started production in October 2004. Other minor prospects include several in the Cortegana–Aroche area.

**Mining:** open pit and underground, scheduled between 2004 and 2013.

**Commodities:** Ni, Cu, Pt, Pd, Co

**Estimated annual production:** 8,000 t Ni, 5,000 t Cu, 600 kg PGE (Pt+Pd).

**Total resources:** 17 Mt @ 0.65%Ni, 0.47%Cu, 0.46 g/t PGE for a cut-off of 0.2 %Ni. Geological reserves are 24 Mt.

**Type:** magmatic hosted Ni–(Cu) deposit.

**Morphology:** subvertical conical pipe with sulphide-supported breccias and massive sulphides hosted by gabbro and gabbronorite with disseminated and globular sulphides.

**Age of mineralization:** intercumulus phlogopite dated at 337 ± 4 Ma (Ar–Ar), consistent with age of other nearby equivalent intrusions (350 to 330 Ma) (Tornos et al., 2004).

**Ore minerals:** pentlandite, chalcopyrite, violarite, cobaltite, PGM (see Ortega et al., 2004).

**Early magmatic mineralization**: the breccia includes fragments of pyroxenite and minor peridotite, gabbro–gabbronorite and host rocks (marbles, skarn, hornfels) in a matrix of pyrrhotite, pentlandite and chalcopyrite with trace amounts of magnetite, cubanite, cobaltite, graphite and mackinawite (Fig. 3). The disseminated and globular mineralization has the same assemblage but is impoverished in nickel.

**Alteration:** the primary magmatic assemblage is pervasively retrograded to amphiboles (actinolite, Mg-hornblende), biotite, epidote ss, talc, chlorite, calcite and illite. The alteration is accompanied by a major redistribution of the ore minerals, including the formation of coarse-grained chalcopyrite, pentlandite, pyrite, pyrrhotite, and some mackinawite, bravoite, sulphosalts and Pd and Pt–Pd tellurides. The deposit underwent major supergene alteration with formation of violarite and marcasite.

**Nature and age of host rocks:** irregularly zoned plutons made up of calc-alkaline, K-rich quartz-diorite and gabbro. The orebody occurs in a small screen of more mafic rocks in the northern part. The pluton intruded limestone, felsic volcaniclastic rocks and hornfels of Upper Neoproterozoic to Early Cambrian age, affected by high-grade contact metamorphism.

**Genetic model:** Geochemistry shows that the mafic magmas at Aguablanca underwent major crustal contamination, probably with siliciclastic rocks within the crust of the Ossa Morena Zone, acquiring sulphur and developing an immiscible sulphide-rich magma (Casquet et al., 2001). Below the Ossa Morena Zone at about 10 to 15 km depth there is a large subhorizontal reflective body that has been interpreted as mafic sills (Simancas et al., 2003). The formation of localized transcrustal extensional structures within the regional transpressional setting

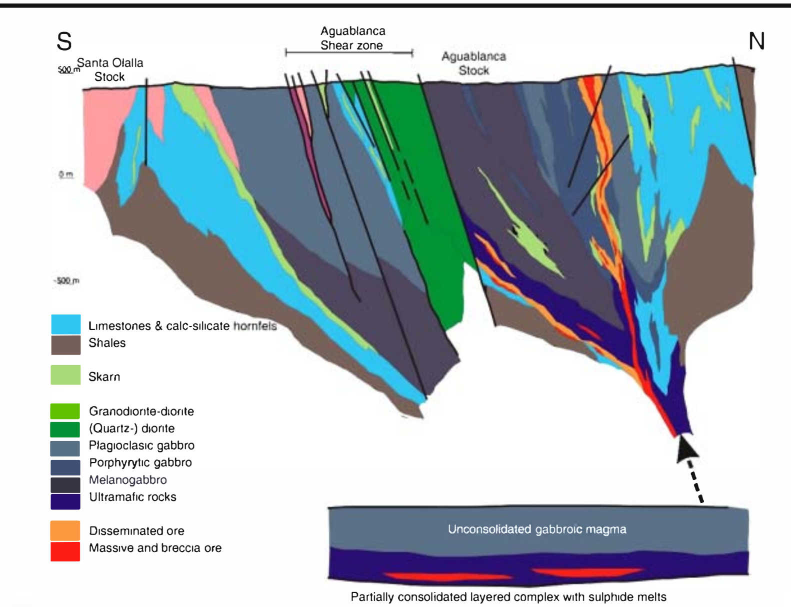



Fig. 2. Interpretative N–S section of the Aguablanca deposit. The lower part of the figure represents a deep stratiform magmatic complex with immiscible sulphide melts perhaps equivalent to the mineralization found in the Aracena Massif (not to scale). Based on unpubished data of Rio Narcea Recursos and Tornos et al. (2001)

probably induced partial crustal decoupling and intrusion of juvenile magmas. Magma–crust interaction and partial crystallization took place in the deep magma chamber. Further reactivation of localized extensional structures allowed the injection to shallow crustal levels of molten sulphide melts, fragments of partially consolidated mafic–ultramafic cumulates and residual melts of gabbroic–gabbronoritic composition (Tornos et al., 2001).

**References:**

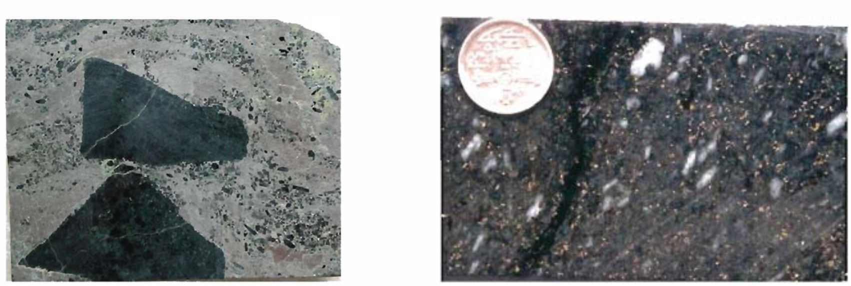
Casquet, C., Galindo, C., Tornos, F., Velasco, F., 2001. The Aguablanca Cu–Ni ore deposit (Extremadura, Spain), a case of synorogenic orthomagmatic mineralization: Isotope composition of magmas (Sr, Nd) and ore (S). Ore Geology Reviews 18, 237–250.

Ortega, L., Lunar, R., Garcia Palomero, F., Moreno,T., Martin Estevez, J.R., Prichard, H.M., Fisher, P.C., 2004. The Aguablanca Ni–Cu–PGE deposit, Southwestern Iberia: Magmatic ore-forming processes and retrograde evolution. Canadian Mineralogist 42, 325–350.

Simancas, J.F., Carbonell, R., Gonzalez Lodeiro, F., Perez Estaun, A., Juhlin, C., Ayarza, P., Kashubin, A., Azor, A., Martinez Poyatos, D., Almodóvar, G.R., Pascual, E., Saez, R., Exposito, I., 2003. Crustal structure of the transpressional Variscan orogen of SW Iberia: SW Iberia deep seismic reflection profile (IBERSEIS). Tectonics 22, 1–16.

Tornos, F., Casquet, C., Galindo, C., Velasco, F., Canales, A., 2001. A new style of Ni–Cu mineralization related to magmatic breccia pipes in a transpressional magmatic arc, Aguablanca, Spain. Mineralium Deposita 36, 700–706.

Tornos, F., Iriondo, A., Casquet, C., Galindo, C., 2004. Geocronología Ar–Ar de flogopitas del stock de Aguablanca (Badajoz). Implicaciones sobre la edad del plutón y de la mineralización de Ni–(Cu) asociada. Geotemas 6, 181-92.



(a) (b)

Fig. 3. Photos of mineralization in the Aguablanca deposit: (a) Breccia-like ore including fragments of pyroxenite supported by massive sulphides. The sulphides also host millimetre-sized crystals of euhedral pyroxene. Sample size: 10 cm; (b) Gabbronorite with disseminated mineralization.