Geophysical Research Abstracts
Vol. 13, EGU2011-1891-2, 2011
EGU General Assembly 2011

Birbirite occurrence in the Ronda peridotites (Betic Cordilleras, southern Spain)

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The term birbirite, after the Birbir River, was introduced by Duparc et al. (1927) for reddish and iron bearing quartzitic rocks originated from Mg-leaching of ultrabasic rocks of the Yuddo massif (Ethiopia). Nowadays, it is considered that birbirite, a cherty aspect rock commonly associated with gold, platinum and mercury deposits, evolved from the silicification of listvenites or serpentinized ultramafic rocks.

The studied birbirites are located at the eastern part of Sierra the Cartama (Malaga, southern Spain), where a small slice of the Ronda peridotites crops out. The birbirites are hard and black resistant siliceous masses, 1 to 25 cm thick, arranged as sheet or veins cutting the primary structures observed in the peridotites (foliation, mafic layering). These metasomatic rocks are composed mainly of microcrystalline quartz, chalcedony/quartz veins, spinel and opaque minerals including pyrite and Ni-Fe sulphides. Dolomite is also present as small rhombohedra crystals sometimes replaced by late microcrystalline silica. A blurred mass network of synisotropic SiO_2 enclosed within fine microcrystalline quartz defines its texture. Pseudomorphic ghost-textures like mesh and bastite and even relict grains of spinel with holly leaf morphologies are common.

Birbirite has high silica content (93.4 %), low Fe_2O_3 (2.9 %) and high loss on ignition (3.1 %) values. Its extremely high silica content compared with their precursors (e.g. peridotites $\approx$ 35 %; serpentinite $\approx$ 40 %; listvenites up to 85 %) suggests the incorporation of extra SiO_2 to the metasomatic system. Trace elements like Co, Ni, Cr and V show concentrations similar to those of the surrounding ultramafic rocks, which imply that neither the serpentinization of the ultramafic rocks, nor the silicification of the serpentinites have reseted the mantle signature of the ultramafic protoliths.

The birbirites of Sierra de Cartama derive from already serpentinized peridotites, as they retain ghost textures from their precursors. The channelling of hydrothermal fluids enriched in SiO_2 and CO_2 through discontinuities can be considered as the main mechanism for their formation. Such fluids must have low fO_2 and fS_2 in order to promote the sulphides precipitation. Two different stages can be accounted for birbirite formation. In the first one, the addition of CO_2 would decrease the pH of the hydrothermal solution favouring the decomposition of serpentinite and the liberation of silicic acid, which would go completely to the observed microcrystalline quartz. A local carbonation, a common process during the early stages of the silicification of the serpentinites (Boschi et al, 2009) is also present. In the second stage, additional silica should be introduced from silica-supersaturated fluids lowering the pH and favouring new silica precipitation and carbonate dissolution. Finally, the estimation of birbirite temperature formation is not straightforward, but the presence of Fe-Ni sulphides as pyrite and maybe millerite (Craig, 1973) would constraint its formation temperature to below 200 ºC. These low-temperature conditions are consistent with the presence of chrysotile-lizardite as the most common serpentine polymorph in the Ronda peridotite massifs.

Boschi et al., 2009. Chem. Geol., 265, 209-226.
Duparc et al., 1927. R. Soc. Physique Genève, 44, 3.
Craig, 1973. Amer. J. Sci., 273-A, 496-510.