Metamorphic evolution and fluid composition of lapis-lazuli-bearing carbonate-evaporitic rocks from Sare Sang in Badakhshan (Western Hindu Kush, Afghanistan)

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The lapis-lazuli deposit at Sare Sang is part of a Precambrian terrigenous carbonate-volcanic sequence that intercalates basaltic rocks. Textural relations and metamorphic fabrics in metapelites and metabasites indicate increase of metamorphic pressures and temperatures to transition of eclogite-amphibolite facies boundary and a subsequent retrograde P-T trajectory to amphibolite facies conditions. The metapelites are characterized by the presence of garnet, biotite, plagioclase, K-feldspar and Al_2SiO_5 phases, showing the P-T path involved change by compression from sillimanite to kyanite stability fields and subsequent decompression along an overall clockwise loop. The metabasites contain garnet, calcic amphiboles, plagioclase ± biotite and clinopyroxene + plagioclase symplectites that might represent a replacement product after omphacite. Maximum P-T conditions of 1.2-1.3 GPa at 700-750 °C were deduced from thermobarometric calculations. The peak pressure and temperature assemblages in metacarbonate-metaevaporites involve olivine, clinopyroxene, garnet, plagioclase, scapolite, phlogopite, calcite, dolomite, quartz and rarely K-feldspar, nepheline, rutile and graphite. Scapolite composition varies, depending on the whole rock composition, from marialite to mizzonite. Clinopyroxene with maximum jadeite content of 29 % occurs in Na-rich metaevaporite. Sodalite, lapis-lazuli, and some amphiboles and apatite, belong to later formed phases in the rocks. Fluid composition during metamorphism is constrained by investigation of carbonate, scapolite, apatite, amphibole and phologopite-biotite. The presence of flour- and chlorapatite and composition of amphibole and phlogopite indicate high concentration of halogen during metamorphism.