

Blue spinel in marble from Luc Yen, North Vietnam

B. CHAUVIRE^{1*}, B. RONDEAU¹, V. PARDIEU²
AND E. FRITSCH³

¹LPG Nantes, CNRS UMR 6112, Universty of Nantes, France

(*correspondence : boris.chauvire@univ-nantes.fr)

²GIA Bangkok 10500, Thailand

⁴IMN, CNRS UMR 6502, BP 32229, 44322 Nantes, France

North Vietnam is a major producer of vivid blue spinel for the gem market. In the Luc Yen district, marble mountains contain several of blue spinel mines. This is the first occurrence where blue spinel is mined in primary deposits, making it possible to investigate the geological condition of its formation. Blue spinel occurs in an intensely deformed area which is part of the Red River Shear Zone [1]. Its marbles have already been studied for ruby deposits and proved to be an old carbonaceous platform which underwent the Indosinian and Himalayan orogenies [2]. We documented the blue spinel host rock by petrography, Raman and SEM examination. The marble contains ferrous sulfides (mainly pyrrhotite), humite-group minerals, apatite and pargasite. Chlorine and fluorine are present in pargasite and humite minerals, suggesting an evaporitic contribution to metamorphism. Sulfides contain significant amounts of titanium, nickel, chrome and cobalt. These elements are also present in spinel (up to 50 ppma of Co as measured by ICP-MS-LA). We propose an ultramafic contribution to explain this transition metals enrichment. These elements may be transported and/or concentrated by fluids during the intense metamorphism like described in this area. UV-Vis spectra of spinel show characteristic bands for tetrahedrally coordinated divalent cobalt Co^{2+} (545, 580 and 625 nm) and iron Fe^{2+} (bands around 380 nm and at 550, 560, 590 nm). All this strongly suggests that cobalt is responsible for the blue color, together with iron. Vivid blue stones are typically rich in cobalt and poor in iron compared to the common greyish blue spinels colored by iron. The source of cobalt is traced back to a contribution of nearby ultramafic rocks during metamorphism.

[1] Garnier *et al* (2005), *The Canadian Mineralogist*, **43**, 1315-1329 [2] Garnier *et al* (2002), *Chemical Geology*, **188**, 33-49