Mineralogical studies on high-temperature skarns in Romania: A way to understand the changes in the Portland-type clinkers and cements,

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The calcic skarns are basically composed by carbonates and by silicate phases that can be easily related to the $CaO - SiO_2 - H_2O - Al_2O_3$ system (Reverdatto, 1970; Korzhinskii, 1970), usually described as C-S-H-A phases by the cement researchers (e.g., Taylor, 1997). Normally, the Portland cement clinkers contain mainly C-S-A phases, the cement itself being the product of a series of quenching and hydration processes conducing to a C-S-H-A system (Taylor, 1997). The study of the clinker phases, as well as those in the cement, is notoriously difficult because of the small dimensions of the compounds crystals. Parallels with the phases in the "natural cements" from the in-situ self-combusted formations from Maquarin (Jordan) and Hatrurim (Israel) were drawn (Gross, 1977). Higher crystallinities and better conditions of study are, however, characteristic for the skarns, but these rocks were never investigated as natural laboratory for understanding the hydration reactions in the cement clinkers. The reason for ignoring calcic skarns as potential model for the clinker and cement studies was probable the mineralization superposed on most of the skarn systems. The ideally systems for such kind of studies exist, however, and are the high-temperature skarns, that are generally barren.

The occurrences of high-temperature calcic skarns are relatively rare. Worldwide, various authors have reported over thirty records of such rocks (cf. Reverdatto 1970, Piret 1997). They were extensively studied because of their importance to understand the evolution of the igneous rock - host rock systems at high temperatures (500-800°C) and low pressures (up to 3 kbar). Classical works were conducted by Tilley & Harwood (1931) at Scawt Hill (Northern Ireland), by Burnham (1959) at Crestmore (California), by Agrell (1965) at Kilchoan (Scotland), by Sabine & Young (1975) at Carneal (Northern Ireland), by Henmi et al. (1977) at Fuka, Mihara and Kushiro (Japan) by Jamtveit et al. (1997) in areas in the Oslo Rift (Norway), etc.

Only three occurrences of high-temperature calcic skarns are currently reported in Romania. Two of them are located at Măgureaua Vaţei and Cornet Hill (Metaliferi Massif, Apuseni Mountains). Ştefan et al. (1978) and Istrate et al. (1978) then Marincea et al. (2001) and Pascal et al. (2001) described skarns with gehlenite and tilleyite - spurrite - gehlenite respectively. The third site is located at Oraviţa (Banat), where Constantinescu et al. (1988)

and Katona et al. (2003) mentioned a gehlenite - spurrite skarn. The lack of modern means of investigation (e.g., electron microprobe, performing X-ray diffraction, transmission electron microscopy and inductively coupled plasma - mass spectrometry), has reduced in most of the cases the possibilities of investigation. Consequently, complete mineralogical and geochemical descriptions have not been undertaken. Excepting the study of Marincea et al. (2001) the studies bring no essentially new data on the secondary phases in the C-S-A-H system that are expected to occur. No reliable data are available on the hydration phases from Oraviţa and Măgureaua Vaţei. As principal result, the study of Marincea et al. (2001) gave the first information on few mineral species previously unknown in Romania such as scawtite $Ca_7(Si_6O_{18})(CO_3)\cdot 2H_2O$, xonotlite $Ca_6Si_6O_{17}(OH)_2$, tobermorite $Ca_5[Si_6O_{16}(OH)_2]\cdot 2H_2O$, riversideite $Ca_5Si_6O_{16}(OH)_2\cdot 2H_2O$, portlandite $Ca(OH)_2$, plombièrite $Ca_5H_2Si_6O_{18})\cdot 6H_2O$.

Practically, only very few research units in Romania were involved in studies concerning the natural C-S-H-A phases, the principal results being achieved by teams from the Geological Institute of Romania and the Universities of Bucharest and Cluj working on skarns and skarn deposits. In spite of the publication of preliminary results in ISI-ranked journals (i.e., *Canadian Mineralogist*: Marincea et al. 2001; Pascal et al. 2001), the utility of the study of C-S-H-(A) phases in skarns for the cement industry was not enough substantiated, the necessity of this study being fully justified.

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