TRACE ELEMENT ABUNDANCES IN St. AUBIN (UNGR iron) GIANT CHROMITE AND ASSOCIATED PHASES.

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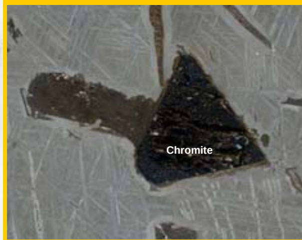
Introduction: Chromite crystals of up to 3 cm in size were recently described from the fine octahedrite Saint Aubin [Fehr and Carion, 2004]. The crystals are euhedral exhibiting triangular and hexagonal cross sections and are incompletely covered by schreibersite, troilite and swathing kamacite. They are accompanied by schreibersite, troilite, hibbingite and euhedral Fe-phosphate (sarcopside or graftonite). We have analyzed the non-metallic phases for their major, minor and trace element contents with an EMP and IMS-3f ion probe, which was also utilized to search for extinct ^{53}Mn in the Fe-phosphates – all following routine procedures.



Results: Chromite is pure $FeCr_2O_4$ containing (in ppm) ~8000 V, ~4700 Mn (but only ~600 Mg and ~0.4 Al), 0.15 Nb, 0.02 Sc and <0.003 Ce. The Fe-phosphate is also pure $(Fe,Mn)_3(PO_4)_3$ with (in ppm) ~18000 Mn, ~2000 Mg, ~270 Zn, 12.5 Cr, ~ 6 Co, 4.2 Ni, 0.01 Nb, 0.0017 Sc and ~0.0003 Ce. Hibbingite, $Fe_2(OH)_3Cl$ (~18 wt% Cl), contains (in ppm) 6200 Ni, 2500 Co, 292 Mn, 0.0003 Sc and 0.0005 Ce. Fe-phosphates have excesses in ^{53}Cr with an initial ratio of $^{53}Mn/^{55}Mn = (1.5+/-0.3)x10^{-6}$.

Figure 2C: Hibbingite (center) parly filling a void with spindle-like cross section, which is now filled by resin. The oxide is fine-grained and contains also numerous pores.

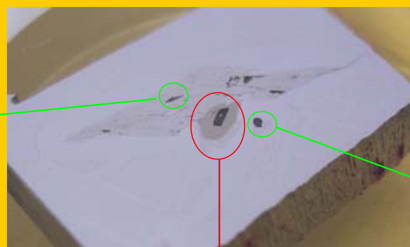


Figure 1: The sample Saint Aubin A investigated. In the center of the polished metal block is visible the cross section of a skelettal schreibersite (rich in cracks and inclusions). Attached to it on the lower side is a troilite including a Fe-phosphate (see Fig. 2A) and isolated in the metal is a phosphate-schreibersite intergrowth (see Fig. 2B). The big spindle-like inclusion in the center of the schreibersite contains hibbingite (see Fig. 2C). Length of the block is 2 cm.

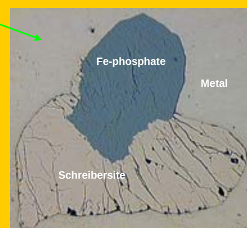


Figure 2B: Fe-phosphate (dark, center) is covered by schreibersite on one side (crack-rich phase) and both are embedded in metal. Note the reaction relationship with schreibersite eating the phosphate. Length of picture is 0.75 mm.

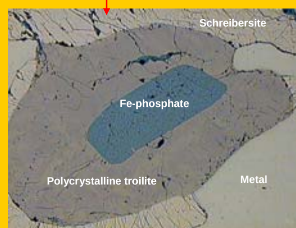


Figure 2A: Fe-phosphate (center), in the Saint Aubin iron, euhedral and with prismatic habit, is enveloped by polycrystalline troilite, which in turn is partly covered by schreibersite (crack-rich phase) – the contact on top is with the large schreibersite visible in Fig. 1. Length of picture is 2.3 mm.

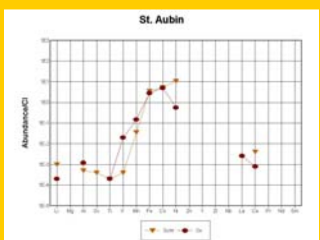


Figure 3: CI-normalized (normalization data from Anders and Grevesse, 1989) trace element contents in chromite and Fe-phosphate from the Saint Aubin iron (A). Note the very low contents of lithophile and siderophile elements in both phases. Exceptions are Li (in phosphate), V (in chromite), Mn, Fe, Zn and Nb.

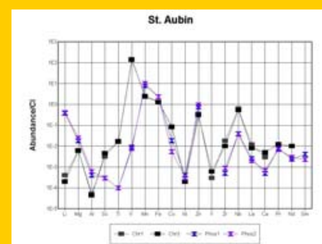


Figure 3: CI-normalized (normalization data from Anders and Grevesse, 1989) trace element abundances in schreibersite (Schr) and hibbingite (Ox) of the Saint Aubin iron. Note the very low contents of lithophile elements in both phases and the increased abundances of V, Mn, Fe, Co and Ni in both phases.

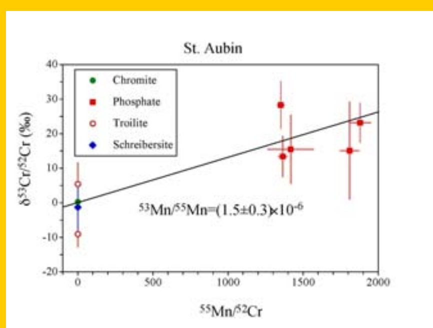


Figure 4: Plot of d53Cr/52Cr vs. 55Mn/52Cr of some phases from the Saint Aubin iron meteorite. The Mn-bearing Fe-phosphate shows clearly an anomaly in the 53Cr abundance. The isochron has a slope defining the original ratio of 53Mn/55Mn = (1.5+/-0.3)x10-6.

Discussion: All non-metallic phases in Saint Aubin are extremely poor in lithophile elements. Particularly striking are the very low contents of Al, Mg, Sc and Ti in chromite as compared to those reported by, e.g., [2]. Also, the contents of Zr and the REE are very low, all <0.01xCI. We interpret this to indicate derivation of the chromite from an environment that was very poor in all these elements. The same holds for the Fe-phosphate. Chromite and phosphate are also very poor in Ni, less so in the less siderophile Co, indicating equilibration with metal. On the other hand, chromite and phosphate are enriched in V and Nb and also Zn and Mn with respect to the common lithophile elements, indicating an elevated siderophile behavior of V and Nb – as was predicted by [3] - and formation of chromite and phosphate from reduced precursor phases. Hibbingite likely is a secondary phase after lawrencite and indicates also low abundances of lithophile elements during formation of the latter in the presence of metal.

Conclusion: All non-metallic phases in Saint Aubin indicate formation in an environment that was very poor in lithophile elements. The abundance anomalies in V and Nb indicate reduced precursor phases (metals, carbides, etc.), which subsequently were oxidized to form chromite and Fe-phosphate early in the history, about contemporaneously with the Mn-Fe metasomatism event experienced by the angrites [4], while some ^{53}Mn still was alive. Thereafter, troilite and schreibersite formed, followed by lawrencite and final metal which preserved all phases.

References: [1] Fehr and Carion 2004. MAPS 39, A139-A141. [2] Bunch et al. 1970. Contr. Mineral. Petrol. 25, 297-340. [3] Jurewicz et al. 1995. EPSL 132, 183-198. [4] Lugmair and Shukolyukov 2002. MAPS 37, 1001-1013.