

## The valence state of iron in chromite from the Luobusa massif of Tibet: Mössbauer spectroscopy studies

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The Mössbauer spectroscopy studies show that chromites from massive ore are characterized by  $Fe^{3+}/\Sigma Fe = 0.42$ , and chromites from nodular and disseminated ores contain  $Fe^{3+}/\Sigma Fe = 0.22$ , all are from a Tibetan ophiolite. The massive ores record traces of ultrahigh pressure minerals: diamond, exsolution lamellae of coesite and diopside in chromite, inclusions of metal-nitrides, SiC and  $Fe^{\circ}$ , the latter indicate a strongly reducing environment. In contrast, chromites from nodular and disseminated ores contain abundant low-pressure OH-bearing mineral inclusions whose formation requires a more oxidizing environment. The high value of  $Fe^{3+}/\Sigma Fe$  in the 'reduced' massive ores is explained by stabilization of  $Fe^{3+}$  in a high-pressure polymorph of spinel deep in the upper mantle through a mechanism such as charge coupled substitution, or creation of oxygen vacancies, accompanied by Fe disproportionation to balance charge. We suggest that the massive chromite and their host peridotite were transported in the solid state from a highly reduced deep mantle (>300km) to an ocean spreading center. In this shallow environment they partially reacted with their host peridotite in the presence of hydrous melt, yielding the nodular and disseminated chromite ores as proposed previously. Given that the high pressure highly-reduced mineral assemblage within the Tibetan massive chromite is not unique, similar examinations of chromites worldwide and high-pressure experiments on reduced Cr-rich systems should help to decipher further the missing history of the deep mantle processes that are involved in their formation.

## Applications of LA-ICP-MS in geoanalysis – New technologies and future perspectives

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Advances in laser ablation sampling have allowed this technology to become mainstream in many laboratories, with most users to date in the geochemical sciences. Laser ablation provides direct solid sample chemical analysis, without requiring sample preparation or consumables and without generating waste solvents. For laboratory measurements, femtosecond laser ablation with ICP-MS can provide accuracy and precision comparable to that achieved using conventional liquid nebulization; although using much less sample than would be required for digestion [1, 2]. Current developments in laser ablation are showing promise for field use and for nanometer spatial scale resolution. The use of near-field optics or femtosecond far-field focusing can provide the ability to measure grains and grain boundaries, with sub-micron spatial resolution [3]. For field use, laser induced breakdown spectroscopy (LIBS), a laser ablation process, can be configured into in suitcase-sized, battery operated self contained system. LIBS offers the geologist the ability measure light elements (Li, Be, etc) in the field, in real time [4]. This presentation will summarize state of the art capabilities in laboratory laser ablation ICP-MS and field LIBS based capabilities for geoanalysis.

[1] Baudelet (2009) *SPIE* **7214** 72140-10. [2] Brostoff (2009) *J Archeological Science* **36** 461-466. [3] Zorba (2010) *Analytical & Bioanalytical Chemistry* **396** 173-180. [4] Piscitelli (2009) *Spectrochimica Acta Part B: Atomic Spectroscopy* **64** 147-154.