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High-pressure behaviour of Cr-Fe-Mg-Al spinels: applications to diamond geobarometry

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Spinels belonging to the chromite – magnesiochromite – hercynite (FeCr2O4-MgCr2O4-FeAl2O4) system are among the most common inclusions found in diamonds (Stachel and Harris 2008). In particular, although FeCr2O4 and MgCr2O4 components sum to between 85 and 88% of spinels found in diamonds, hercynite FeAl2O4 plays a not negligible role in determining their thermo-elastic properties with concentrations reaching 7-9 % (other minor end-members like MgAl2O4, MgFe2O4 and Fe2O_3 rarely reach 2-3% in total, see Lenaz et al. 2009). Recent studies were focused on the determination of the diamond formation pressure by the so-called "elastic method" (see for example Nestola et al. 2011 and references therein). It was demonstrated that accurate and precise thermo-elastic parameters are fundamental to minimize the uncertainty of formation pressure.
In this work we have determined the equations of state at room temperature of three synthetic spinel end-members chromite – magnesiochromite – hercynite and one natural spinel crystal extracted from a diamond (from Udachnaya mine, Siberia, Russia) by single-crystal X-ray diffraction in situ at high-pressure. A diamond-anvil cell was mounted on a STADI IV diffractometer equipped with a point detector and motorized by SINGLE software (Angel and Finger 2011). The natural crystal was investigated to test (and possibly validate) the "empirical prediction model", capable to provide bulk modulus and its first pressure derivative only knowing the composition of the spinels found in diamonds. Such prediction model could be used to obtain pressure of formation for the diamond-spinel pair through the elastic method. Details and results will be discussed.

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