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Magnetic susceptibility of natural diamonds

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Magnetic properties of diamonds are widely used in diamond mining and gemology for diamond/minerals and natural/ synthetic diamonds separation, respectively: thus any new information concerning diamond magnetic properties is very valuable. The most wide spread magnetic technique is an electronic spin resonance (ESR) which reveals a fine structure related to point defects and allows one to determine their structure. Much fewer information is present concerning a magnetic susceptibility χ which is useful to characterize a force acting on diamond in an external magnetic field. Natural diamonds are known to be diamagnetics ($\chi<0$) but the values vary from paper to paper. Magnetic susceptibility of synthetic diamonds is usually positive ($\chi>0$) because of the strong input from the inclusions of metal catalysts (usually 3d ions such as Fe, Ni and Co).

A study of magnetic susceptibility χ of a large batch natural diamonds from Yakutia depending on temperature and magnetic field force allowed us to separate diamagnetic, paramagnetic and ferromagnetic inputs. A value of diamagnetic component due to a prefect diamond matrix was made more precise: $\chi_d = -0.446 \cdot 10^{-6}$ cm³/G whereas variation in its values was related to inclusions both of diamagnetic compounds such as graphite and ferromagnetic ones. We found diamonds of fibrous structure related to group V by Yu. Orlov which demonstrate a well-pronounced hysteresis loop in magnetization dependence on magnetic field force. Although natural metals (Fe, Ni) have been found in naturals diamonds, an analysis of the loops parameters shows that the ferromagnetism is due not to metal inclusions but to some mineral inclusions. Taking into account a high iron concentration in natural diamonds (tens ppm according to X-ray fluorescence analysis with synchrotron excitation or even up to several hundreds ppm according to LAM ICP MS) the ferromagnetic input can be due to some Fe-containing inclusions and their type/composition are discussed. Their input may exceed that of diamagnetic matrix and make magnetic susceptibility value positive, which in turn affects the separation process.

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