The nonmagnetic field in the parent body of Tagish Lake (CI2) when magnetite was formed due to aqueous alteration

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Tagish Lake is the most primitive carbonaceous chondrite (CI2) that fell to Canada in 2000. The density is 1.67 according to Zolensky et al. (2002). We studied magnetic properties of this meteorite focused on when and where the NRM was acquired. The results of AF demagnetization of NRM up to 100 mT showed that the NRM was stable up to 30 mT and the directions made a cluster with a95=43.5 and K=5.4 at the demagnetization of 30 mT. The NRM was thermally demagnetized up to 630C in the vacuumed condition. The NRM intensity decreased stepwise to 430C, but it increased after 530C. During the demagnetization, the NRM direction did not drastically change. The sample acquired SRM by 1.0 T and then it was demagnetized to 100 mT. The SIRM intensity was steeply demagnetized up to 30 mT with peak value at 10-20mT, while residual SIRM was 24-28% to 30 mT and 9-11% to 100 mT. The temperature dependence of the hysteresis parameters was obtained up to 800C with the external magnetic field 1.0 T. The saturation magnetization (Is) disappeared at 630C, while the value increased at 270 and 560C. Coercivity value was stepwise demagnetized at 150 and 360C and disappeared at 570C. This curve is roughly similar to the thermal demagnetization of NRM. Susceptibility suddenly increased at 280-360C and 500-560C. The former corresponds to decreasing of Hc value and the latter relates to increasing of Is value. The susceptibility disappeared finally at 560C. Magnetotactic bacteria were applied to the surface polished in the NRM state. The bacteria made small and weak clusters at random in the matrix and some sulfide. When the sample acquired the SIRM, the bacteria made strong clusters on the phyllosilicate rims of chondrules and clasts, but weak clusters were formed on sulfide grains. As the rims were yielded by aqueous alteration lower than 200-375C (Zolensky et al., 2002), the magnetic minerals were created in the phyllosilicate rims at the alteration. The distributions of Fe, Ni and S in the strong magnetized areas were examined by EPMA. The results indicated that the phyllosilicate rims included abundant Fe and minor S. Ni and S concentrated on the sulfide formed along the boundary of chondrules and rims. So a dominant magnetic mineral in Tagish Lake is concluded to magnetite, while sulfide (pyrrhotite and pentlandite) is minor.

The NRM survived up to 30mT against AF demagnetization. If the external magnetic field was present during the aqueous alteration in the parent body, the magnetic grains having Hc>30 mT must have a responsibility for NRM. This evidence is inferred to no magnetic field or the negligibly weak field when magnetic minerals were formed in the parent body. Low density of Tagish Lake might avoid shock magnetization or shock demagnetization when it was crushed at the collision with other asteroids. Therefore, the most plausible acquisition of NRM is VRM origin acquired after the formation of phyllosilicate rims in the parent body, in the space or earths magnetic field.