Effect of Pressure on Absolute Paleointensity Recording

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Abstract: Understanding how meteorites acquire and retain magnetic remanence lends insight into the magnetic fields present during the formation of their parent bodies. However, meteorites often experienced a complicated strain history, from shock, decompression from depth in the original parent body, etc. Because compression and decompression can influence a material's magnetic properties, we studied how pressure cycling can affect the paleointensity record.

Thellier-type experiments were carried out on 40 samples whose magnetic remanence is carried by pseudo-single domain, low Ti titanomagnetite--typically found in some achondritic meteorites. The initial (zero pressure) experiment correctly reproduced the laboratory field imparted on the samples. The samples were given a new thermo-remanent magnetization, encased in a Teflon cup, and then pressurized in a stainless steel pressure vessel. Salt (NaCl) or silicon oil were used as pressure media.

Pressure cycling to 0.6 GPa using salt as a pressure medium provoked a pressure demagnetization effect that reduced the room-temperature thermo-remanent magnetization by 22±8%. The measured paleointensity diminished 15%, from a 35.0±0.2 µT lab field to 29.4±0.8 µT. We found no difference between a magnetization imparted perpendicular or parallel to the maximum stress axis. Using silicon oil has a pressure medium, which is more hydrostatic than salt, renders the material more resistant to pressure-demagnetization, with 14±2% magnetization lost per GPa at room temperature.

Macroscopic strain effects are only observable when pressures exceed 5 GPa. Because peak pressures even as low as 1 GPa will considerably underestimate the original field intensity, one should view paleointensities derived from stress-cycled samples as minimum values.

Keywords: pressure, paleointensity, meteorite

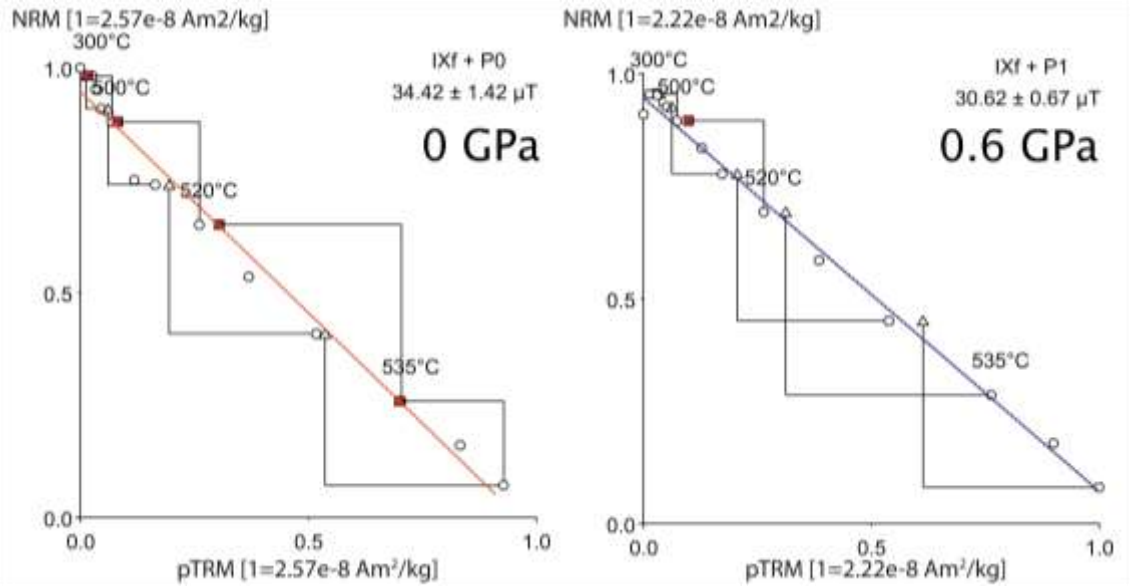

Figure 1: Arai plots of the same sample, left in the unpressurized state, right after application of 0.6 GPa along the direction of the NRM. Pressure changes the slope of the plot and lowers the calculated paleointensity.

References :

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