J. Geophys. 42, 85–87, 1976

Journal of Geophysics

Further Utilization of the Fluxgate Magnetometer in the Palaeomagnetic Laboratory

R. Hummervoll

Department of Geophysics, University of Bergen, Bergen, Norway

Key words: Fluxgate probes used as detectors – Automatic magnetic balance – Palaeomagnetic laboratory.

The high field magnetic balance is a useful instrument for experimental work in rock magnetism and palaeomagnetism. Several types of balances have been constructed and some of them have been made automatic (Nagata, 1961). The main principle used in such balances is based on that of 'weighing' counter-balancing forces. To detect the deviation from the rest position, application of photo-cells, photo-transistors, condensors or some sort of inductive bridge balances have been used, but another alternative is to apply fluxgate probes which are available in most palaeomagnetic laboratories. The probes, placed centered to an extra magnet mounted on the translation pendulum (cf. Fig. 1), are to be opposed to each other. This is because the field from the strong

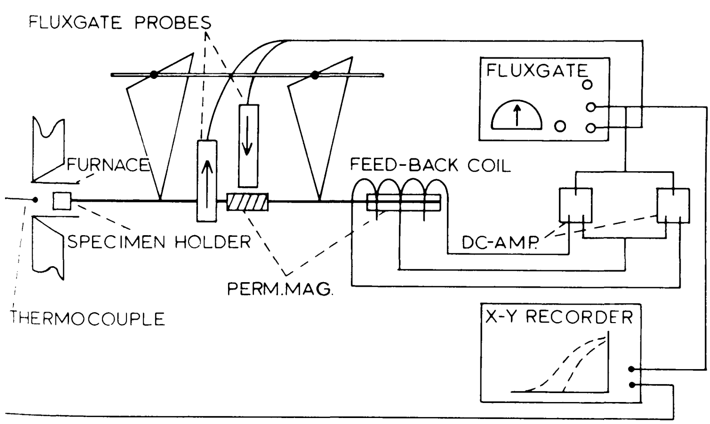

Fig. 1. Schematic diagram of the arrangement of the automatic translation balance with the fluxgate magnetometer as an active element in the feedback loop

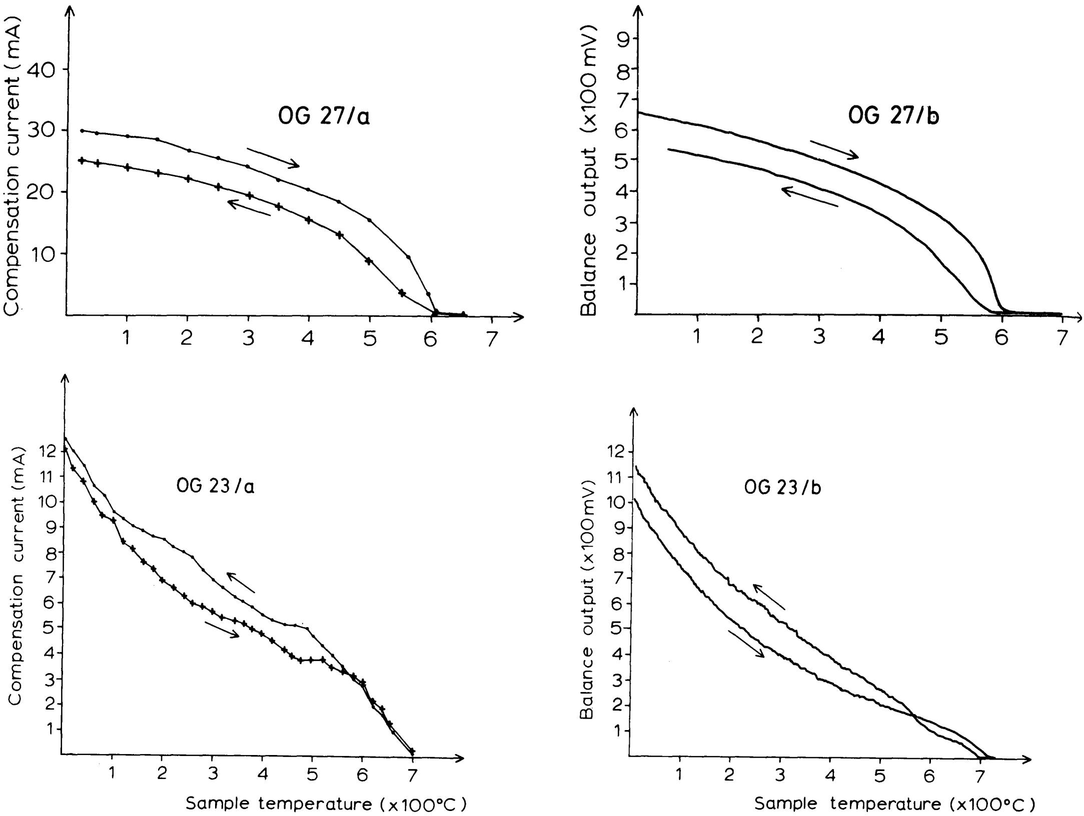

Fig. 2. Two pairs of curves which compares manually obtained results (a) with x–y Chart recordings (b). The initial susceptibility (Ko) for the two materials used (basalt and sediment) are 4.2 10^{-3} emu/cm^3 and 3.6$10^{-7}$ emu/cm^3 respectively. Applied fields: 3.5 kOe for No. OG27 (basalt) and 6 kOe for No. OG23 (sediment)

electromagnet (which may vary slightly) would otherwise cause a too big influence on the recording system, for example in terms of drift etc. The small extra magnet should be magnetized along the direction of the pendulum as well as being rather short. A short magnet will minimize the effect of the gradient field from the electromagnet at the same time as yielding an optimum field response for the detecting probes (a short magnet has a stronger curvature of its lines of force than a larger magnet).

The arrangement here described may give a very sensitive recording system and a commercial oerstedmeter contains most of the necessary electronics. The only extra equipment needed is two simple dc-amplifiers which act as buffer stages in connection with the feedback arrangement as illustrated in Fig. 1. The feedback coil is centertapped with two halves wound in opposition; this is partly done to counteract the zero current in the two dc-amplifiers and partly to enable the equipment to be applied for complete thermal cycling (heating and subsequent cooling).

The sensitivity of the equipment will, among other things, depend on the position and distance of the probes relative to the permanent magnet as well as of the magnetic moment of the latter. The system here described has been applied at the Department of Geophysics, University of Bergen, for more than two years—in this set-up the minimum detectable movement of the pendulum 0.05 mm is obtained when the sensitivity range of the fluxgate magnetometer (Dr. Förster) is set at 1/20 of maximum value. In practice, it has not been necessary so far to operate on higher sensitivity ranges.

Fig. 2 shows thermal cycling results of two separate specimens having widely different initial susceptibilities. As illustrated in the diagram the specimens having the stronger susceptibility exhibit hardly any difference between manually obtained results and those recorded automatically. On the other hand, the specimens of low magnetic susceptibility (of the order typical for many sediments) exhibit a number of extra inflections on the manually obtained curves, a feature which is non-existent in the automatically recorded results. Thus, it appears that one should be extremely cautious when analysing manually obtained saturation magnetization (J_s) versus temperature curves from specimens having low susceptibilities (of the order of 10^{-7} emu/cm^3); the recorded inflections may easily be interpreted in terms of mineralogical properties and changes while they most likely are due to recording/instrumental imperfections.

On a whole, the principle of using the fluxgate magnetometer as a detector and active element in the feedback loop of an automatic translation balance has proved to be a success. The system remains stable for days and the noise caused by external sources is of negligible importance even under workshop conditions. Furthermore, the applications of the fluxgate system concerned simplifies the performance of an automatic balance; the set-up here described may be duplicated with a minimum of technical facilities.

Reference

Nagata, T.: Rock magnetism. Tokyo: Maruzen 1961

Received October 10, 1975