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Drilling-induced remanent magnetization in basalt drill cores

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SUMMARY

Drilling-induced remanent magnetization (DIRM) in drill cores can limit their use for magnetostratigraphic studies and preclude the use of secondary viscous remanence for their azimuthal orientation. DIRM was studied in a drill core of a thick Miocene basalt flow now buried at 0.45 km. Due to zonation of the magnetic properties within the flow, DIRM was observed in specimens whose remanence is controlled by grains ranging from multidomain (MD) to single domain (SD). DIRM in this drill core has the following properties: (1) it is characterized by high intensity and low stability; (2) the DIRM intensity increases by at least a factor of 5 from the centre of the drill core to the drill string's cutting surface, where it appears to have been produced; (3) it is directed down and radially inward towards the centre of the drill core; and (4) it is relatively more dominant and more intense in magnetically less stable MD grains.

The observed DIRM can be modelled as a pure IRM acquired in a field of the order of 10 mT. Therefore, the DIRM in this drill core is most easily explained as having been produced during the initial drilling by a strong non-uniform field concentrated near the cutting rim of the drill string. Other processes which might contribute to DIRM production include tearing of grains and possible changes in strain, mechanical shocks and piezo remanent magnetization (PRM).

In this drill core, DIRM in the magnetically less stable grains was more effectively cleaned by alternating fields (AF) than by thermal demagnetization, and judicious AF demagnetization was usually successful at defining the primary remanence, especially for specimens from the centre of the drill core, which are less affected by DIRM overprinting. The use of a non-magnetic drill string would further reduce, and might possibly eliminate, DIRM production.

Key words: DIRM, drill core, IRM, PRM, secondary magnetization

1 INTRODUCTION

The use of drill cores for palaeomagnetic studies may be severely limited by the imposition of secondary remanence during drilling. We have studied drilling-induced remanent magnetization (DIRM) in a basalt drill core, and in this paper we report on the magnetic properties of the DIRM and attempt to determine its origin.

Extensive palaeomagnetic studies of Columbia River Basalt (CRB) drill cores in Washington State, USA, indicate that many of the cores have a superimposed steep secondary magnetization, which can dominate the natural remanent magnetization (NRM). This secondary remanence is usually characterized by low coercivity and low blocking temperatures. Van Alstine & Gillett (1981) reported that, in seven of 11 drill cores they studied, the NRM was severely affected by drilling. In our palaeomagnetic investigations of the nearly 60 m thick Roza flow in these drill cores, we had to analyse this secondary magnetization in order to isolate the primary remanence (Audunsson & Levi 1984; in preparation). In this paper we describe this secondary remanence, which, we believe, was produced primarily by the original drilling. In this drill core, alternating field (AF) demagnetization was usually successful at defining the primary remanence in specimens from the centre of the drill core.

The tholeiitic mid-Miocene Roza flow is about 15 Ma, and has an intermediate palaeomagnetic direction, nearly horizontal and to the south (inclination $\approx -5°$ and declination $\approx 189°$). The Roza is underlain by the normal polarity Frenchman Springs flows and overlain by the reverse Priest Rapids units; hence, the Roza probably erupted in the midst of a geomagnetic polarity transition, while the geomagnetic intensity was relatively low.

Palaeomagnetic studies of both sedimentary and volcanic rocks have documented that significant spurious magnetizations can be introduced during drilling or sawing (e.g. Kuster 1969; Rainbow, Fuller & Schmidt 1972; Sallomy & Briden 1975; Ade-Hall & Johnson 1976; Lowrie & Kent 1976; Rice, Hall & Opdyke 1980). However, the origin of this secondary remanence was examined only in a relatively few studies. Burmester (1977), Lauer (1978) and Jackson & Van der Voo (1985) observed that DIRM was produced parallel to the external field during sawing and was