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A Method to Reduce the Measuring Time for Spinner Magnetometers

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A slow speed spinner of the Foster type (Foster, 1966) consists mainly of a 5 cps spinner shaft, a commercially made lock-in amplifier with two separated amplifier channels and a millioersted magnetometer (fluxgate). The usual measuring procedure for this and other types of spinner magnetometers is a 6-spin technique (Phillips and Kuckes, 1967). Each spin gives 2 separated components of the magnetic moment, one in phase with and the other in quadrature with the shaft reference. A complete measurement will thus exist of a 12-moment observation, with 4 readings for each of the three components x, y and z. The four readings are such that the positive and negative value of each component is read on each channel of the amplifier. This procedure gives a sufficient random operation for most specimens and reduces possible drifts in the zeros as well as in the relative gains of the two amplifying channels. The procedure, however, is rather tedious and each measurement takes from 5 to 12 minutes depending on the intensity of the specimen.

The different orientations of the specimen in the spin shaft is achieved by manual operations which require a stop of the spin before each reorientation. Fig. 1a and b indicate two of the six orientations, giving the x- and y-component with either sign, alternatively on the two output meters. The spin condition of configuration b), however, may be obtained from the one at a) without any turning of the specimen. With reference to Fig. 1a) and b) it is shown that the succession of the x and y vectors in the spin-directions of the two configurations have been interchanged. This is the same as reversing the spin of the shaft. It is further shown that the phase relation between the reference and the x-axis is displaced ninety degrees in the case of b). Thus, if a new reference source, with the proper phase relation, is added to a) at the same time as the spin direction is reversed, the spin condition of b) is attained (see Fig. 1c). This is obtained simply by the

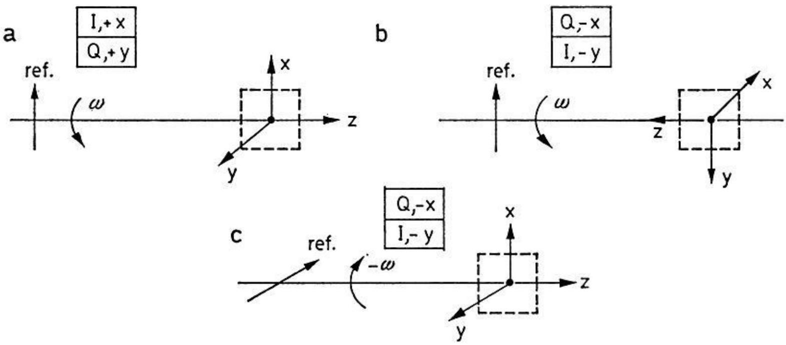

Fig. 1. a and b Schematic diagram of the spinning shaft and two of the six orientations of the specimens. c Alternative method with another reference and a reversed spin direction. I: in phase meter. Q: quadrature meter

use of an electric switch. The new technique simplifies the procedure by reducing the number of manual operations from six to three. The time gained for each measured specimen, will on average approximate to 20—25 per cent.

As shown in Table 1 the two measuring techniques show good agreement. Irregularities which could be connected to the new simplified method have not been observed. Two possible cases, however, which may depreciate the results should be mentioned here. Firstly, this is if the specimen holder is displaced relative to the centre of the fluxgate probes at the same time as the specimen is strongly inhomogeneous (Fig. 2a). The off-centre effect will of course be active in the conventional procedure as well, but in this particular case a better cancellation of the effect is obtained. However,

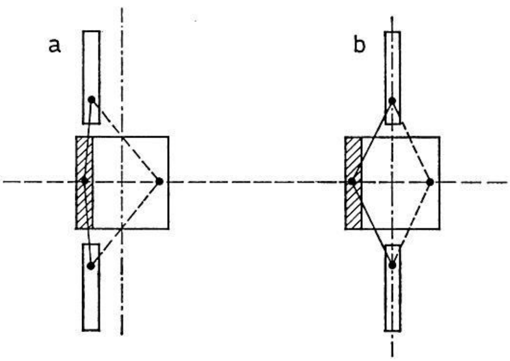

Fig. 2. The figure illustrates the effect of inhomogeneities if the specimens are displaced axially relative to the centre of the fluxgate probes. The shaded area is imagined as the magnetic part of the specimen. a off-centre position. b on-centre position

Table 1. Some of the results from the test between the old and new method

Sample	Old method D	Old method I	Old method Intensity [Gauss]	New method D	New method I	New method Intensity [Gauss]
SK 18b	321.8°	75.3°	$0.1378 \cdot 10^{-1}$	321.5°	76.5°	$0.1363 \cdot 10^{-1}$
SK 18a	282.0°	—50.5°	$0.1609 \cdot 10^{-2}$	281.7°	—49.5°	$0.1611 \cdot 10^{-2}$
SK 18c	265.2°	—41.4°	$0.1621 \cdot 10^{-2}$	264.6°	—40.7°	$0.1610 \cdot 10^{-2}$
AG 44	312.3°	—10.0°	$0.2768 \cdot 10^{-3}$	311.6°	— 8.9°	$0.2728 \cdot 10^{-3}$
AG 12	292.5°	—53.4°	$0.5210 \cdot 10^{-3}$	293.0°	—53.9°	$0.5157 \cdot 10^{-3}$
BS IIIa	171.5°	1.4°	$0.1567 \cdot 10^{-4}$	172.5°	2.0°	$0.1552 \cdot 10^{-4}$
AG 95	284.3°	—29.1°	$0.5728 \cdot 10^{-4}$	283.9°	—30.4°	$0.5794 \cdot 10^{-4}$
PR a	160.7°	— 6.4°	$0.1267 \cdot 10^{-5}$	164.9°	— 3.1°	$0.1355 \cdot 10^{-5}$
CO 38	323.4°	—22.0°	$0.8016 \cdot 10^{-5}$	320.2°	—23.1°	$0.8056 \cdot 10^{-5}$

for instruments properly centred problems of this kind should not arise. Secondly, another possible drawback may be introduced if the two reference sources have a different drift. A mechanical rotation of one reference source by 90° instead of an electric switching between two sources would prevent such a possibility.

As mentioned before the method has been tried out on ordinary rock specimens (cf. Table 1) as well as on various artificial test specimens. The latter attempts were basically performed to study any effect from inhomogeneities. The test specimens, consisting of disks cut from ordinary rock sylinders, were displaced axially in the specimen holder as illustrated in Fig. 2b). Nothing unusual was observed as long as the specimen holder is centered with respect to the probes.

References

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