TABLE I. *Olivine dolerite, Dùn Mingulay (9700). Anal. D. L. Skinner*

	Chemical analysis	Trace elements (in ppm)		Weight norm		
SiO_2	44·28	Li	8	Q		—
TiO_2	2·15	V	192	Or		3·19
Al_2O_3	16·33	Cr	38	Ab		22·38
Fe_2O_3	2·60	Co	52	An		26·72
FeO	13·49	Ni	59	Ne		4·46
MnO	0·21	Cu	86	Di	Wo	5·04
MgO	6·80	Ga	28		En	2·32
CaO	8·20	Rb	63		Fs	2·67
Na_2O	3·62	Sr	295	Ol	Fo	10·24
K_2O	0·54	Y	11		Fa	12·97
P_2O_5	0·32	Zr	206	Mt		3·77
H_2O^+	1·59	Sn	< 5	Il		4·08
CO_2	0·25	Cs	< 25	Ap		0·76
Total	100·38	Ba	225			
		La	< 35			
		Pb	< 7			

Modal analysis

Labradorite (An_{58})	55·5	Titanaugite	18·3
Olivine	20·2	Opaque ore	6·0

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Computerized data processing from an X-ray texture-goniometer

OVER the last few years, the classical interest in the orientation properties of mineral crystals has received a new impetus, but in a somewhat non-classical direction. Universal stage techniques, which are suitable but time-consuming and tedious for examinations of structural and crystallographic features in larger minerals, are much less suitable for studying in detail any preferred orientation in fine-grain mineral aggregates comprising components down to clay grade sizes. New applications of X-ray diffraction techniques appear to offer the greatest potential.

Metamorphic and structural geologists have a fundamental interest in rock fabrics but a situation has now arisen in which soils engineers are gradually appreciating the importance of clay mineral orientation and re-orientation in problems concerned with soil strength and stability (see, for example, Mitchell, 1956; Skempton, 1964). Indeed, questions of interparticle bonding in clay–water systems, the nature of the bonding, and the bond/mineral-orientation relationships (see, for example, Rosenqvist, 1962) are rapidly assuming great importance in soil mechanics.

For a simple, two-phase, monomineralic clay/water system it is possible to examine optically the laboratory relationships between mineral orientation and pressure (Morgenstern and Tchalenko, 1967). Conclusions drawn from the experimental deformational behaviour of such a simple non-typical system cannot readily be extrapolated to the behaviour of a natural polymineralic aggregate. There is also the added disadvantage that by necessarily restricting an examination to the relatively high-symmetry basal planes of the clay minerals, the presence of an absolute preferred orientation (referred to a multi-component mixture) in a triaxial stress field may not be discernible.

X-ray texture-goniometric methods have been progressively developed over the years and equipment based on the Schulz (1949) analysis is available commercially. This method, in theory, permits a total scan of the sphere of projection for a particular Bragg angle setting related to a selected *(hkl)* lattice plane and hence ultimately to the construction of a fabric diagram for the chosen *(hkl)* plane. Practical constraints upon the choice of available planes arise from the inevitable peak overlaps and from the degree of resolution acceptable at the counter input. Nevertheless, although the technique is most safely applied to an examination of the basal planes of micaceous minerals, it can still be used for texture analyses on certain planes other than basal provided that the influence of any superimposed or adjacent reflections can be assessed by referring to comparative symmetries and plane multiplicities. Examples of this approach are to be published (Attewell and Taylor, 1969, in press).

The commercially available X-ray texture equipment also suffers from a further limitation. Although the scan is progressive and automatic, the output is in the form of an analogue chart record (intensity in counts per second versus angles in azimuth and latitude) from which the information must be plotted manually. Depending upon the complexity of the record, the fabric detail, and the experience of the abstractor, a fabric diagram can take up to 4 h to plot. As a result, a review was made of several possible methods of reducing the effort in the data-processing sector. Semi-mechanical systems such as that proposed by Chirer (1967) seemed to be less attractive than one that could offer a digital output suitable for computer processing and a rapid, automatic fabric plot-out. A versatile program has now been written in PL/1 for use with a Philips type PW 1078 texture-goniometer and processed on an IBM 360/67 computer, and is to be published.

The program, which specifically accommodates examinations in the reflection mode, will give an output via a digital voltmeter, external to goniometer control, with counts at discrete intervals of time as a function of both rotation in azimuth and tilt in the latitudes; a digital clock is used for precise timing, there are no constraints on the interval chosen and the scan is uninterrupted; the chart can be run in parallel for a visible check on operation.

Alternatively, the timer and scaler circuits of the counter control can operate an interrupted step scan (through a goniometer drive relay) with the goniometer interrogated on the run or by counting over a pre-set interval of time during the stationary phase; in the first case, the size of the step is related to a function of time, which is recorded on the output; in the second case no counts are taken during goniometer-run.

The digitized record is on 8-hole tape and under the present scanning and sampling conditions there are some 1500 data points per fabric, for runs up to 70° of tilt in the latitudes. The program can accept any number of data points less than a pre-set X-ray count array, and is fully compatible with any combination of parameter settings on the texture-goniometer proper. Procedurally, the computer scans the data points, counts them, subtracts a background (which is the final data point punched on the tape) and then normalizes all intensities in counts per second to the maximum output. In other words, all counts are then expressed as percentages of maximum in increments of 10 %.

The program prints the fabric out directly on the line printer with a choice of either stereographic or equal area projection. There is also a net expansion and segmentation facility.

An option of progressive re-plots of the same data for different specified degrees of rotation on the projection is available. This acts as an indirect check between textures for the same (*hkl*) settings on differently oriented specimens of the same material. It also opens up the possibility of rotation into orientations equivalent to other (*hkl*) planes for the same mineral fixed in space and hence offers a facility of progressive record cleaning on composite peaks. There is also an option of a progressive throughput and progressive fabric plots from several data runs.

The total computer time per fabric (compilation, processing, and printing) is about ½ min.

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