

Letters to the Editor

Investigation of the landslide at Walton's Wood, Staffordshire
EARLY, K. R. and SKEMPTON, A. W. 1972, *Q. Jl Engng Geol.* 5, 19–41

In their pertinent account of the Walton's Wood slide the Authors show that slip surfaces have probably been subject to subsequent chemical reduction at some period during the time interval, Late-Glacial to Present. As they point out, the much lower Fe_2O_3 content of the shear zone material (Table 4) is convincing supporting evidence.

Work in connection with unburnt colliery spoil heaps implies that significant low temperature chemical changes involving clay-minerals in Coal Measures rocks are unlikely to be short-term processes (for example, Spears *et al.*, 1971). A recent study of Spoil Heap No. 1 at Littleton Colliery, Staffordshire suggests that chemical and mineralogical differences between a recently exposed failure surface (probably reactivated) and other, non-burnt, spoil samples are very minor indeed. Here again, this is in the short-term since the original failure probably took place about 25 years ago and is certainly not more than 50 years old.

Quantitative X-ray mineralogical analyses are somewhat restricted in accuracy as implied by Early and Skempton (p. 29). However, quartz determinations by X-ray methods are usually reasonably accurate, and a high degree of precision is expected in chemical analyses. It is therefore of interest to consider both sets of Walton's Wood analyses (Table 3 and 4) in an attempt to postulate further on the important evidence of secondary chemical reduction, which the Authors attribute to water percolation along the slip surfaces.

With a restricted mineral assemblage (Table 3) it is feasible to attribute alumina (Table 4) to the clay-minerals (alumino-silicates) and more effectively, to rationalize in terms of alumina as denominator. Part of the SiO_2 (Table 4) can be accounted for by quartz, for which a reasonable estimate can be accepted (Table 3). The remaining combined silica (expressed as a combined silica/alumina ratio) provides a guide to clay mineral variations—ratio 1.54 for ambient clay, 1.43 for the shear zone.

Theoretical and empirical combined SiO_2 /alumina ratios for monomineralic kaolinite are about 1.18, whilst illites like the Fithian illite (which includes mixed-layer clay) have ratios of around 1.98. If the ambient clay ratio is assumed to be correct then the quartz percentage would necessarily be only 5½ per cent for the ratio to remain constant in the shear zone material: such an under-estimation is not very likely.

It is therefore suggested from the combined silica/alumina ratios that under the reducing conditions recorded, clay-mineral changes towards the more stable form, kaolinite (see Jackson 1964) are taking place. An increase in kaolinite of around 10 per cent could possibly be involved, at the expense of illite and mixed-layer clay. This is not unreasonable in view of the environment to which kaolinite formation can be assigned (Millot, 1970, p. 325). Even when the removal of iron is allowed for an increase in kaolinite would appear to be feasible. Such a change is unlikely to be detected by X-ray diffraction.

Some portion of all other element oxides (Table 4) can also be attributed to clay-mineral lattice constituents. TiO_2 however, may well be present purely as rutile inclusions in clay-minerals and quartz. It can be seen from the values given by the Authors that apart from $\text{CaO}/\text{Al}_2\text{O}_3$, a decrease occurs in all cases in the transition from ambient to shear zone material. The increase in $\text{CaO}/\text{Al}_2\text{O}_3$ in the shear zone may be symptomatic of the presence of secondary gypsum, but there are no sulphur determinations to confirm this. In any case, transportation from outside the immediate environment could account for this difference.

Of major import is the decrease in the $\text{K}_2\text{O}/\text{Al}_2\text{O}_3$ ratio because K^+ is a prime lattice component of illite and mixed-layer clay. This element is obviously being leached from the lattice and the combined SiO_2 /alumina ratios infer that micaceous minerals may have been partially transformed to kaolinite.

It will be of interest to see if more definite evidence emerges in support of clay-mineral changes taking place across ancient slip planes. The importance of such changes in the context of stability is that ionic bonds may also be changing along failure surfaces over protracted time intervals, possibly with long-range bonds being replaced by shorter range types. Reducing solutions percolating along shear surfaces are of interest on their own merits, particularly if their source is normal groundwater.

SPEARS, D. A., TAYLOR, R. K. & TILL, R. 1971. A mineralogical investigation of a spoil heap at Yorkshire Main Colliery. *Q. Jl Engng Geol.* 3, 239–252.

JACKSON, M. L. 1964. Chemical composition of soils. p. 71–141. *Chemistry of the soil.* (Editor BEAR, F. E.) Reinhold Publishing Company, New York, 515 pp.

MILLOT, G. 1970. *Geology of clays.* Springer-Verlag, New York, 429 pp.

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Discussion on "Engineering problems caused by fossil permafrost features in the English Midlands" by A. V. MORGAN (*Q. Jl. Engng. Geol.* **4**, 1971, pp. 111-4).

Dear Sir,

The above paper describes a pipe trench excavation, made through a till sheet north of Wolverhampton, in which failures occurred through the presence of a polygonal system of ice-wedge casts. The failures were of two types: either wash-outs of the sand infilling

the casts or collapses of blocks of the till bounded by the vertical planes of weakness formed by the casts.

In his classic papers (1915, 1919) on the permafrost features along the north shore of Alaska, Leffingwell describes low cliffs cut into the frozen tundra by wave or river action which collapsed on the planes of weakness formed by the presence of polygonal ice-wedge polygons. This observation forms an interesting parallel, for active permafrost conditions, with the corresponding mode of failure reported by Morgan for the fossil situation.

LEFFINGWELL, E. DE K. 1915. Ground-ice wedges: the dominant form of ground-ice on the north coast of Alaska. *J. Geol.* **23**, 635-54.

——— 1919. The Canning River Region, northern Alaska. *U.S. Geol. Survey Prof. Paper 109*, (251 pp.).

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