

The field and universal stage observations for each section are related by a single angle read on universal stage axis A_1 .

Each set of universal stage readings is progressively converted as follows: first, into spherical polar coordinates with respect to the plane and pole of the thin section and to the zero of the universal stage axis A_1 ; second, into spherical polar coordinates with respect to the horizontal plane, the nadir, and the cardinal directions; third, into planar polar coordinates with respect to the Schmidt (equal area) net; and fourth, into Cartesian coordinates in the plane of the Schmidt net. After suitable sorting of the points in terms of their Cartesian coordinates, the entire plot is scanned at N-S. and E-W. intervals of $\frac{1}{40}$ of the diameter of the circular plot (equivalent to 0.5 cm intervals with a 20-cm diameter Schmidt net).

The output, a series of numbers in their correct relative positions, gives the percentage of points per 1% of the total area of the plot around each scanning centre. It is, of course, a lower hemisphere equal-area projection on the horizontal plane and has the four cardinal directions imprinted around the margin. Within the limits of the character- and line-spacing of the printing device, it is reasonably near to circular. Contouring can be rapidly carried out by hand or, if a digital plotter is available, the output procedure could be readily modified to take advantage of this.

The programme is written in Elliott 803 Algol 60 and is available from the author on 5-hole tape or in typescript. On the Elliott 803, computing time is of the order of 10 to 15 min depending on the number of points handled, but on a more modern fast computer, this would probably be reduced to something of the order of 1 min.

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Wulfenite from Ysbyty Ystwyth, Cardiganshire

ALTHOUGH rare in the British Isles, wulfenite attracts attention by being easy to recognize even in minute crystals and by containing the uncommon metal molybdenum. Some ten localities are known in England and Scotland, but there seem to be no records from Wales or

Ireland (a supposed occurrence¹ in Pembrokeshire was an error).² We describe an occurrence of wulfenite in the ore-field of central Wales.

The high ground south-east of the village of Ysbyty Ystwyth is occupied by extensive abandoned workings on the parallel, ENE.-trending Glôg-Fâch and Glôg-Fawr lodes, which cut Ordovician shales of the Frongôch formation³. These workings, developed for lead and silver chiefly in the second half of the nineteenth century, lie less than a mile south of the Logau-lâs (or Log-y-lâs) lode, famous for its splendid specimens of crystallized cerussite, but do not themselves feature in the mineralogical literature. The gangue present on the dumps is quartz, with some calcite and ankerite; the primary sulphides are galena, subsidiary blende, and a little chalcopyrite. Small amounts of secondary minerals also occur (e.g. on the small dump outside a cross-cut adit at⁴ 74797048, which meets Glôg-Fawr lode, and on the dumps around Engine shaft on Glôg-Fâch lode, at 749710): cerussite, pyromorphite, malachite, and linarite, all as encrustations and tiny crystals, as well as traces of chrysocolla and brochantite associated with brown 'copper pitch'.

To the east of these main workings are some old trials made in an attempt to locate the lodes beyond a great N-S. cross-course of crushed and sheared rock that cuts across them. It is only on the following dumps of these outlying workings that wulfenite has been found (one specimen in 1963 and many more later): Dumps (A) of the Eastern or Pen-y-bwlch shaft on Glôg-Fawr lode, at 75187100, where wulfenite is associated with yellowish-green minutely crystallized pyromorphite on broken shale or quartzzy gozzan; other minerals here are quartz, galena, chalcopyrite, cerussite, malachite, linarite, chrysocolla, brochantite, and 'copper pitch'. A small dump (B) at an obliterated shallow adit at 75297184, driven along the lode towards Pen-y-bwlch shaft; here wulfenite is found on broken-up pieces of shale and grey cavernous mudstone that are partly encrusted with pyromorphite and drusy quartz, and the dump is poor in other minerals. A long, narrow dump (C) derived from a collapsed adit at 75447136 driven 100 yd. ENE. to a large incline shaft, Taylor's or East Glôg-Fâch shaft, which was sunk on a lode thought to be the continuation of Glôg-Fâch lode; the mineral

¹ S. G. Perceval, *Geol. Mag.*, 1866, vol. 3, p. 377.

² *Idem, ibid.*, p. 518.

³ For details and a plan see O. T. Jones, *Lead and zinc: The mining district of North Cardiganshire and West Montgomeryshire*. Mem. Geol. Survey: Spec. Rep. Mineral Resources of Gt. Britain, vol. 20, pp. 120-126 (1922).

⁴ The figures are National Grid References in square SN.

assemblage on the adit dump is similar to that at Pen-y-bwlch shaft; it includes wulfenite and, in addition, some calcite. Pyromorphite and secondary copper minerals, but no wulfenite, were found on the dumps of Taylor's shaft itself.

The wulfenite crystals, 0.2–1 mm in size, are of three habits: very thin clear yellow rectangular plates (from dump A); groups of clear honey-brown thick bevelled plates (dump B); and orange-brown translucent elongated bipyramids with convex curved edges (dumps A, B, and C).

Secondary minerals were identified by their infra-red spectra, and the identity of the wulfenite was confirmed by an X-ray powder photograph kindly taken by Miss E. E. Fejer of the British Museum (N.H.).

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Coexistence of 'incompatible' ions and concentration processes in two mineral systems

MANGANESE in mineral analyses is commonly stated as MnO when FeO is present, on the grounds that the oxidation of Fe^{2+} by Mn^{3+} in solution indicates instability of this ion-pair in the solid also, and a similar assumption is usually made regarding the pair Ti^{3+} – Fe^{3+} , again on the basis of their behaviour in aqueous solution. Neither assumption rests on a sound theoretical basis, and it is not therefore surprising that exceptions to both have recently been described. Smith and Albee (1965) give analytical data for an equilibrium piemontite–garnet assemblage in which Fe^{2+} , Fe^{3+} , Mn^{2+} , and Mn^{3+} coexist (Mn^{3+} and Fe^{3+} in the piemontite, Fe^{2+} , Fe^{3+} , and Mn^{2+} in the garnet), but were unable to account for the observation, and Chesnokov's (1959) work on the absorption spectra of titanaugites, confirmed and extended by Burns (unpub.), has shown that Fe^{3+} and Ti^{3+} coexist in these minerals.

Nature of species in solution. In any solution, whether solid solution,