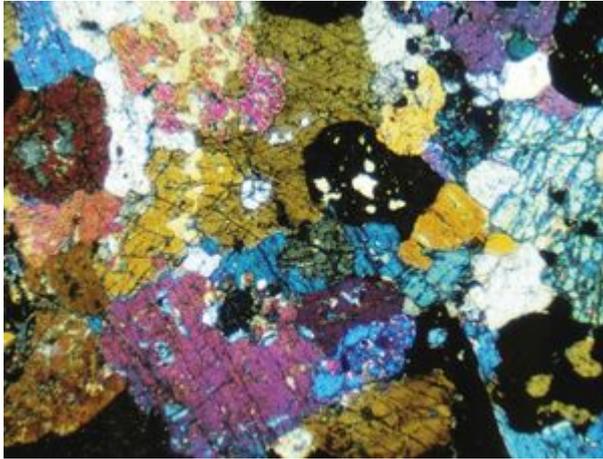


# Tremadoc Series, Ordovician, Wales

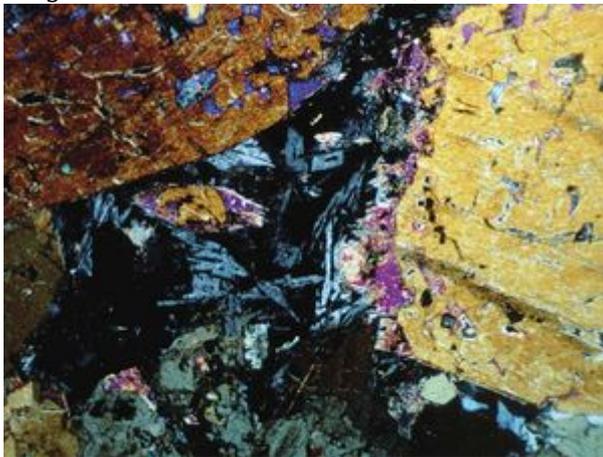
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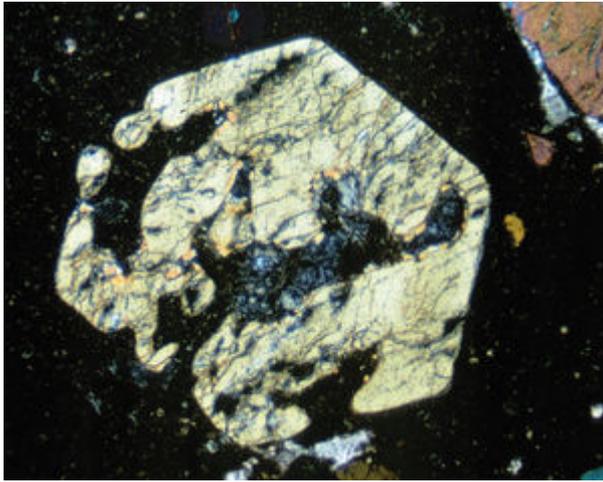
**From:** Howells, M F. 2007. [British regional geology: Wales](#). Keyworth, Nottingham: British Geological Survey.



Photomicrographs (x 10; crossed polarised) of cumulate textures in the Rhobell Volcanic Group (B P Kokelaar). a Pargasite-salite accumulate formed in a magma chamber at more than 30 km below the Earth's surface. Crystallisation of these minerals from the parental basic magma caused the residual magma to evolve to andesite. (P662398).



Photomicrographs (x 10; crossed polarised) of cumulate textures in the Rhobell Volcanic Group (B P Kokelaar). b Pargasite crystals, rimmed with actinolite, were brought up from depth and the interstitial melt cooled rapidly on eruption. (P662399).



Photomicrographs (x 10; crossed polarised) of cumulate textures in the Rhobell Volcanic Group (B P Kokelaar). c Pargasite phenocryst with complex embayments, in fine-grained basalt. The crystal was partly dissolved in the magma before eruption. (P662400).



Photomicrographs (x 10; crossed polarised) of cumulate textures in the Rhobell Volcanic Group (B P Kokelaar). d. Basalt containing a cluster of intergrown plagioclase (glomerocryst) in a groundmass of flow-aligned feldspar microcrysts. (P662401).

From late Cambrian into early Ordovician times there was widespread deposition of mud Tremadoc across the Welsh Basin and its adjacent shelf. In Wales, Tremadoc strata, up to 500 m thick, are exposed around the Harlech Dome, from Arthog on the south side of the Mawddach estuary to the Vale of Ffestiniog and Tremadog in the north. The strata are absent in Arfon and Anglesey, and in Pembrokeshire, but whether they were ever deposited there or were removed during the Arenig transgression is a matter of continued debate. Small outcrops of Tremadoc strata have been proved in Carmarthenshire in south Wales. To the east of Wales, an estimated 1500 m of Tremadoc greenish grey mudstone (Shinerton Shale Formation) accumulated on the platform in the Welsh Borderland probably within a half-graben that developed during an extensional phase of rifting on the Midlands Platform.

Where the base of the Tremadoc is seen, as at Ogof Ddû near Criccieth, and near Ffriog in Arthog, there is a marked change, over 2 to 3 m, from black anoxic mudstone of the Dolgellau Formation to paler grey-green, rusty weathered mudstone with phosphatic nodules at the base of the Tremadoc.

The Tremadoc succession has been given many local formational names, which the Geological Survey has rationalised into the Dol-cyn-afon Formation, comprising marine mudstone, locally bioturbated, with thin, cross-laminated, silty sandstones and some thicker, lenticular sandstone beds. At Ogof Ddû, the graptolite *Rhabdinopora* is found 8.5 m above the base of the formation. Around the northern flank of the Harlech Dome, the graptolite *flabelliformis* and *tenellus* biozones, and the trilobite *pusilla* (or *salopiensis*) and *sedgwickii* biozones are all present, and the sequence is the most complete in Wales. The formation has been subdivided into members on the basis of coarse- and medium-grained volcanoclastic sandstones, although this division is difficult to sustain laterally. Essentially, the sequence reflects a higher energy marine environment than that which prevailed during deposition of the Dolgellau Formation, although in places, particularly in the mudstone near the top, there is evidence of a more restricted shallow shelf and lagoonal environment reflecting the initiation of emergence.

At Dol-cyn-afon, on the eastern flank of the Harlech Dome, only the lowermost *flabelliformis* Biozone is proved. It is possible that the higher part of the sequence was removed by erosion before deposition of the subaerial Rhobell Volcanic Group in late Tremadoc times; the group oversteps the Dol-cyn-afon Formation to rest on the Dolgellau Formation. The Rhobell Volcanic Group is the denuded remnant of a basaltic volcano, which was uplifted and then deeply eroded prior to the marine transgression during early Arenig times. Successive basaltic lava flows, locally autobrecciated, overstep eastwards across a highly irregular surface. Locally some primitive basalts contain cognate cumulate blocks composed dominantly of pargasite with calcic clinopyroxene and Ti-magnetite derived from a compositionally stratified magma chamber ([P662398](#)) ([P662399](#)) ([P662400](#)) ([P662401](#)). The basalts were erupted subaerially from a series of fault-controlled fissures, aligned north-south, which are now marked by a suite of subvolcanic dolerite and dioritic intrusions. Rafts of country rock, which were rotated during magma emplacement, add to the structural complexity. Autobrecciation and hydrothermal alteration have affected all the rocks of the intrusive complex. The complex of subalkaline intrusions within the Cambrian sequence on the Harlech Dome, to the west of Rhobell Fawr, and the porphyry-copper mineralisation at Coed y Brenin are directly related to this magmatic episode.

Along the south side of the Mawddach estuary, the Dol-cyn-afon Formation comprises dark grey mudstone with some laterally impersistent sandstones near the top of the sequence. The mudstone is intensely bioturbated, possibly the result of shallowing prior to emergence. Both the *flabelliformis* and *pusilla* biozones have been determined. Around Mynydd y Gader, south of the Ceunant Fault, the formation has been removed by erosion.

In western Llŷn, rocks of the early Tremadoc, *flabelliformis* and *tenellus* biozones occur at Pen Benar. They are lithologically similar to those around the Harlech Dome, and sandstones near the top of the sequence probably reflect shallowing of the marine environment.

In south Wales, at Llangynog south-west of Carmarthen, grey-green micaceous mudstone has yielded a graptolite-trilobite fauna of Tremadoc age. The trilobites *Pseudohysterolenus* and *Parabolina argentinensis* have not been recorded elsewhere in Britain, but are comparable with forms found in South America. A shallow borehole in Carmarthen Bay, south-west of Worms Head, proved about 2.5 m of dark grey micaceous mudstone of possible *tenellus* Biozone age. At Treffgarne, north Pembrokeshire, basal Arenig strata overlie basaltic andesite and andesite lavas and associated volcanoclastic rocks that are broadly similar in character to the Rhobell Volcanic Group, although their possible correlation remains equivocal.

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