CORRESPONDENCE

A definition of the term ganister

(Plate 1)

SIR – The origin of the term ganister is obscure, and a clear definition seems never to have existed. As a result rocks varying widely in character and lithology have been termed ganister.

The term arose in Yorkshire and Derbyshire, particularly in the Sheffield region, as a local miners' and quarrymen's name for a rock commonly employed as roadstone (Thomas, Hallimond & Radley, 1918; Strahan, 1920). It was applied with absolute precision to highly siliceous rocks occurring in the Lower Coal Measures which possessed definite physical characteristics of fine grain size, good sorting, angular grains, silica cementation and a splintery to subconchoidal fracture (Thomas, Hallimond & Radley, 1918).

The development of the steel industry in the Sheffield region led to a search for rocks suitable as refractories to line the furnaces and coking ovens. Ganisters were ideal for this purpose due to their physical and chemical properties. A sandstone lying beneath the Halifax Hard Mine or Alton Coal (Westphalian A; Ramsbottom *et al.* 1978) provided particularly excellent material for refractory bricks and was extensively worked. Due to its widespread extraction it became known as the Sheffield Ganister, or Sheffield Blue Ganister, on account of its colouration. This horizon became the 'type' ganister (Searle, 1917; Strahan, 1920), (Plate 1a).

The growth of the steel industry in other regions of Britain led to a search for sandstones with similar refractory properties to the Sheffield Blue Ganister. Many of these were called ganisters and the term became something of a trade name (Thomas, Hallimond & Radley, 1981).

It seems appropriate that any definition of the term ganister should be based on the properties and origins of the Sheffield Blue Ganister. Many definitions have been proposed (Lebour, 1886; Searle, 1917; Thomas, Hallimond & Radley, 1918; Strahan, 1920; Williams, Turner & Gilbert, 1954; Williamson, 1967), but none seems sufficiently precise to be universally acceptable. All these authors agreed that a ganister is a fine, even grained, highly siliceous sandstone consisting of closely packed, subangular quartz grains cemented by silica. It is also concluded that they occur commonly as the seatearth below a coal seam and often contain abundant carbonaceous traces or rootlets (hence the name pencil ganister).

Strahan (1920), having defined the term, did not include all rocks with the necessary characteristics as ganisters, but implied that only those siliceous sandstones formed as palaeosols are true ganisters. Subsequently several workers (Searle, 1940; Huddle & Patterson, 1961; Hemingway, 1968; Retallack, 1976, 1977) concluded that ganisters form by silica enrichment during pedogenesis, and the term has attained genetic significance.

Recent studies of the Sheffield Blue Ganister have shown this horizon also has a pedogenic origin (e.g. Pearson, 1979; Ashby & Pearson, 1979; Curtis *et al.* 1980). Thus a new definition of ganister is proposed which takes into account physical properties, mode of origin and economic use. This is based mainly upon the fundamental characteristics of the 'type' Sheffield Blue Ganister.

> 'A ganister is a hard, compact very fine to medium grained quartz arenite (Folk, 1974), cemented by authigenic silica dominantly as overgrowths, formed by silica enrichment of a less mature parent material in a palaeosol. Such horizons contain the necessary physical and chemical characteristics to be used as the raw material in the production of siliceous refractories.'

The parent material from which the ganister developed should contain $< 95\%$ quartz, as sandstones consisting of $> 95\%$ quartz prior to pedogenesis cannot classify as ganisters, and represent sedimentary quartz arenites. In order for a quartz arenite to be useful as a raw material for refractory purposes, it should contain a minimum of 97.5% SiO_2 (excluding carbonaceous material from the total percentage), (K. Pirt, pers. comm.). As a result, to classify as a ganister, the sandstone should consist of at least 95% quartz in thin section.

The lack of abundant cherty, cryptocrystalline or opaline silica cement and TiO_2 rich cloudy areas, the fine to medium grain size and moderately well sorted, grain supported fabric, and the lack of

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evidence of near surface cementation differentiates ganisters from most types of silcrete (Williamson, 1957; Smale, 1973; Watts, 1978; Summerfield, 1979; Summerfield & Whalley, 1980).

True ganisters thus represent quartz arenites containing > 95% quartz which achieved this degree of quartz enrichment by leaching in a palaeosol profile. They are thus the fossilized equivalents of the A_2-horizon of modern podzols and podzolic soils. Formation of these soils requires freely drained conditions and an excess of precipitation over evapotranspiration. This leads to leaching and quartz enrichment in the A_2-horizon, which may become a ganister if cemented by quartz during diagenesis. The recognition of such an origin for a texturally mature quartz arenitic sandstone depends on the occurrence of several of the following criteria:

(1) The presence of roots and rootlets; these commonly decrease in abundance with depth.

(2) Indications of soil horizons. Commonly palaeosol profiles containing a quartz arenite exhibit a carbonaceous top which may be overlain by a thin coal (thick coals are uncommon). Beneath the quartz arenite horizon there is often a clay enriched zone (this varies from a kaolinitic clay to a sandstone which in the topmost metre or so shows a decrease in clay content with depth).

(3) Cutans (Brewer, 1964) beneath the quartz arenite horizon. These commonly occur as clay coatings and pore linings (argillans), and are generally retricted to zones where sandstone underlies the quartz arenite. Preferential development of these features in certain areas may give rise to clay rich laminae (Plate 1 b).

(4) A sharp or transitional basal contact to the quartz arenite. In the latter case the quartz arenite commonly passes down into texturally and mineralogically less mature sandstone. Sharp contacts are generally very irregular and give rise to a 'knobbly' base to the quartz arenite with undulations up to a few tens of cm deep (Plate 1 a). These undulations lack any features indicative of loading, and are similar to the tonguing contacts seen in modern podzols and podzolic soils.

(5) Absence of sedimentary structures. This is generally due to destruction by rootlets and soil organisms as well as obliteration by other pedogenic processes.

(6) The quartz arenite is commonly thin, generally < 1 m, but up to 2 m in extreme cases.

(7) Large variations in the thickness of the quartz arenite horizon, generally due to the irregular basal contact.

(8) Vertical and lateral changes in the lithology of the quartz arenite horizon due to variations in leaching.

(9) Absence of any marine fauna in the quartz arenite.

(10) Lack of features indicative of high energy reworking e.g. well rounded, well sorted grains.

Of these characteristics, the lack of sedimentary structures, and the presence of rootlets and a highly irregular basal contact are often diagnostic of a pedogenic origin for a quartz arenite (ganister) containing > 95% quartz. In addition the quartz arenite is generally very fine to medium grained, and lacks features indicative of silcretes e.g. TiO_2 rich cloudy areas.

Ganisters (as previously defined) may form isolate sandstone layers or the tops to thicker sandstone bodies. This depends on the thickness and lithology of the sandy parent material from which they developed, the time available for leaching, rate of leaching, and the depth to the water table. The amount of quartz enrichment which occurred during pedogenesis is often hard to ascertain unless some parent material has been preserved. Obviously ganisters will develop more rapidly on sandstones already enriched in quartz to some degree. Consequently many examples appear to have undergone < 10% quartz enrichment during pedogenesis. Sandstones containing > 95% quartz prior to pedogenesis and leaching cannot classify as ganisters and constitute sedimentary quartz arenites.

The thickness of the ganister A_2-horizon developed during pedogenesis will reflect a variety of factors including time, parent material, rate of leaching etc. One of the most important factors in this respect is the depth to the water table, as this represents the lowest limit to which the ganister A_2-horizon can develop.

Ganisters thus reflect freely drained conditions; the thickness of the ganister will indicate the minimum possible depth to the water table during formation of the soil profile.

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EXPLANATION OF PLATE

Plate 1. (a)
Exposure of the Sheffield Blue Ganister at Langsett, South Yorkshire (SE 21300105), showing its highly irregular/'knobbly' base. Below the ganister are a series of kaolinitic clays and sandstones. The overlying Alton Coal and Marine Band have been removed in this section. Hammer (H) – 33 cm long.

Plate 1. (b)
Top of the Firestone Sill (Namurian, E_1), Round Hill Quarry, County Durham (NZ01203835) showing the irregularly based ganister (white) overlying subarkosic sandstone containing pedogenic clay rich laminae. Hammer (H) – 33 cm long.

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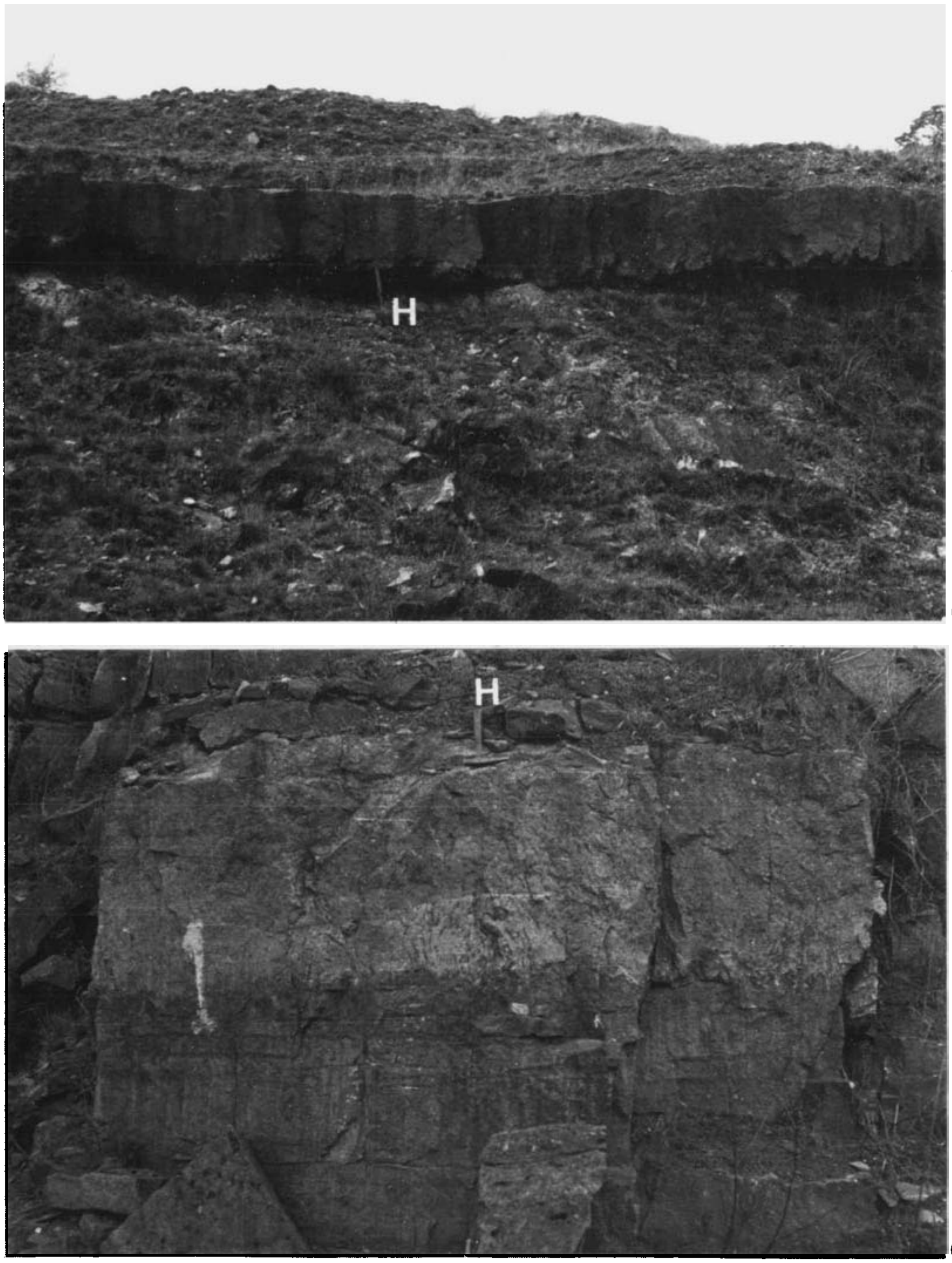

(a)

(b)

Plate 1. Examples of ganister.