Two of the most popular limestone classifications are those of Folk (1959, 1962) and Dunham (1962). These are summarized in Tables 3 and 4 and Fig. E.

Table 3. *Classification of limestones according to Dunham (1962) Rock names are in capital letters*

Original components not organically bound together during deposition				Components organically bound during deposition
contains carbonate mud			no carbonate mud	
mud-supported		grain-supported		
< 10% allochems	> 10% allochems			
MUDSTONE	WACKESTONE	PACKSTONE	GRAINSTONE	BOUNDSTONE

Table 4 *Classification of limestones based on the scheme of Folk (1959, 1962) Rock names are in capital letters*

volumetric allochem composition				> 10% allochems		< 10% allochems			
				Sparry calcite > Micrite	Micrite > Sparry calcite		1–10% allochems	< 1% allochems	Undisturbed reef and bioherm rocks
> 25% Intraclasts				INTRASPARITE	INTRAMICRITE	Most abundant allochems	Intraclasts INTRACLAST-BEARING MICRITE	MICRITE, or if sparry patches present DISMICRITE	BIOLITHITE
< 25% Intraclasts	> 25% Ooids			OOSPARITE	OOMICRITE		Ooids OOID-BEARING MICRITE		
	< 25% Ooids	Volume ratio, bioclasts: peloids	3:1	BIOSPARITE	BIOMICRITE		Bioclasts FOSSILIFEROUS MICRITE		
			3:1 to 1:3	BIOPELSPARITE	BIOPELMICRITE				
			1:3	PELSPARITE	PELMICRITE		Peloids PELOID-BEARING MICRITE		

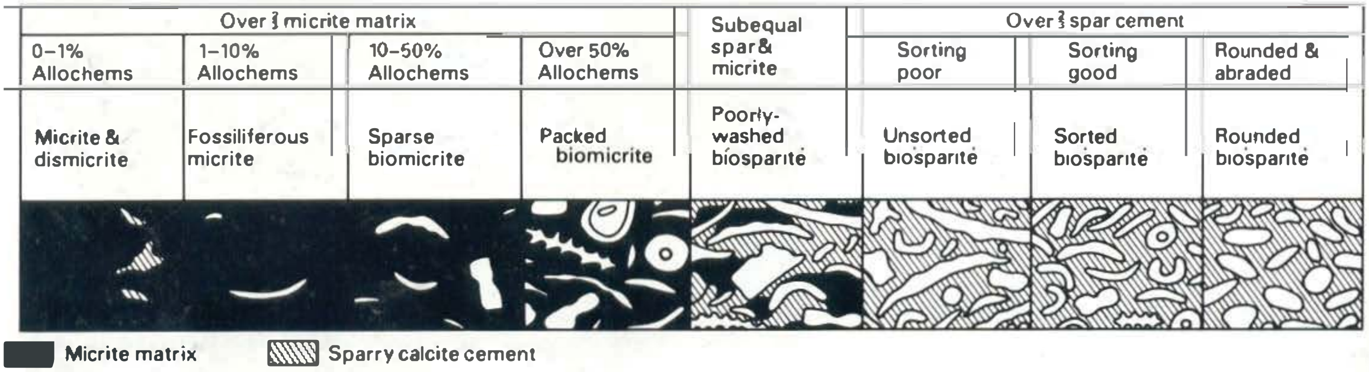
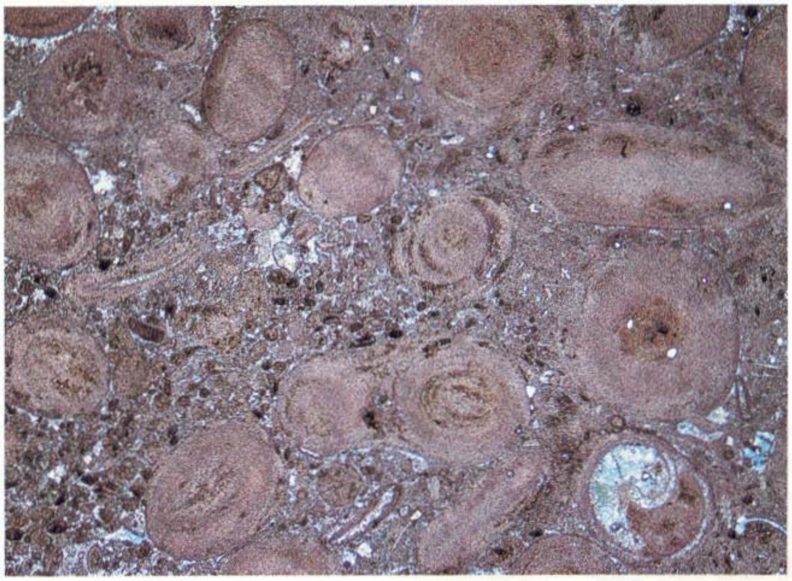


Fig. E *The range in textures shown by carbonate rocks, illustrated using the rock names of the Folk classification (after Folk, 1959)*

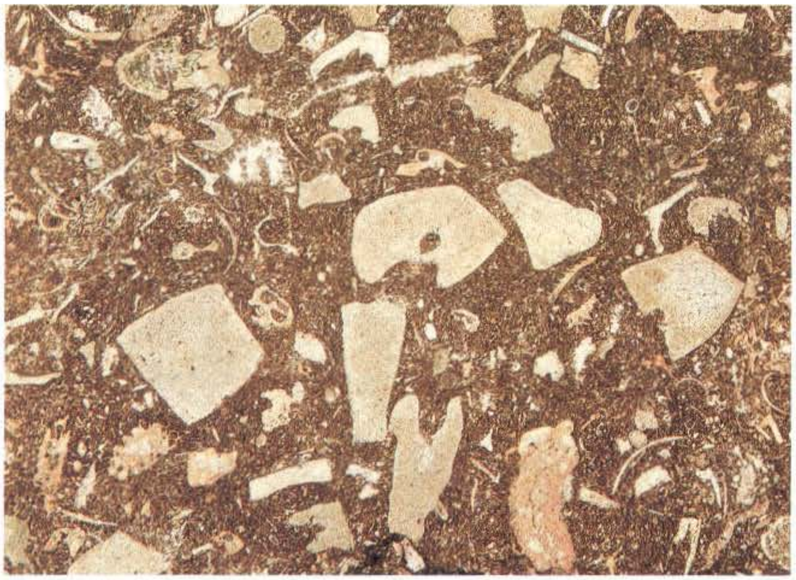
Limestone classification

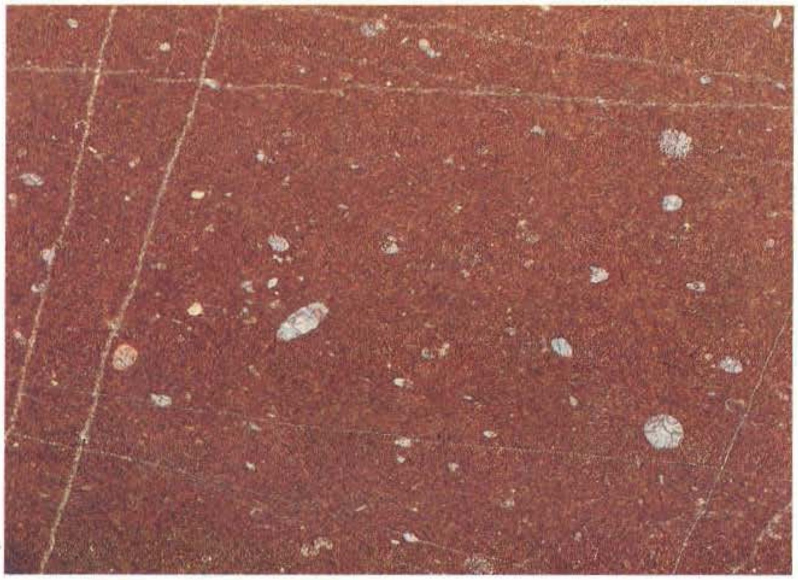
(continued)

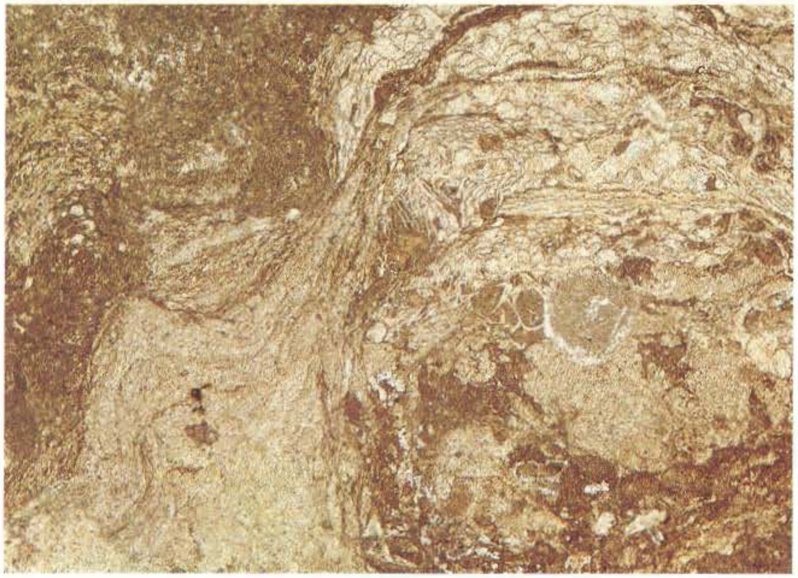
146 illustrates a grainstone. The rock is grain-supported with a spar cement. The sediment is loosely-packed, suggesting that cementation occurred before significant compaction. The allochems are a mixture of ooids (some are superficial ooids, see p. 35) and bioclasts. It is therefore an *oosparite* according to Folk. Since the allochems are rounded it would be a *rounded oosparite*, using Folk's textural spectrum. **147** shows a packstone. The rock shows two sizes of grains, having large and small peloids. The former have a trace of oolitic structure in places and may be micritized ooids (p. 54). The latter are probably faecal pellets. The sediment contains some ferroan calcite cement but also much carbonate mud sediment in the matrix. It is nevertheless grain-supported and thus a packstone. According to Folk's classification it is a *poorly-washed oosparite*.



146: Unstained thin section, Jurassic, unknown locality, England; magnification × 23, PPL.
147: Stained acetate peel, Inferior Oolite, Middle Jurassic, Cooper's Hill, Gloucestershire, England; magnification × 13, PPL.
Other grainstones are shown (Folk classification in brackets) in **73** *(oosparite),* **74** *(oosparite),* **75** *(sorted pelsparite),* **77** *(unsorted intrasparite),* **87** *(unsorted biosparite) and* **124** *(unsorted biosparite).*
Other packstones are shown in **72** *(poorly-washed oosparite),* **79** *(packed intramicrite)* **96** *(poorly-washed biosparite) and* **115** *(packed biomicrite).*







Limestone classification

(continued)

148 shows a wackestone. The grains are bioclasts, mainly echinoderm plates with some bryozoans (e.g. lower left part). These grains are supported by a matrix of carbonate mud in which many small particles are visible at this magnification.

149 shows a mudstone, being a matrix-supported limestone with less than 10% allochems. In this case the allochems are microfossils – foraminifera and calcite casts of radiolaria. The sediment is cut by thin veins of pale blue-stained ferroan calcite. This sample is a *fossiliferous micrite* according to Folk's classification.

A boundstone is a limestone in which sediment is bound together by organisms, such as occurs in many reefs. Textures are often more clearly visible at hand-specimen scale. **150** shows a thin section of a reef limestone comprising growths of a number of problematic organisms (probably algae or foraminifera) which have encrusted one another while incorporating fine-grained sediment into the rock framework.

148: Stained acetate peel, Wenlock Limestone, Silurian Shropshire, England; magnification × 11, PPL.
149: Stained thin section, Upper Cretaceous, Pindos Zone, Greece; magnification × 43, PPL.
150: Stained thin section, Red Hill Oolite, Lower Carboniferous, Elliscales Quarry, Dalton-in-Furness, Cumbria, England; magnification × 12, PPL.
Other wackestones are shown (Folk classification in brackets), in 105 (biomicrite) and 156 (biomicrite).

Limestone Porosity

Any description of a limestone should include an evaluation of the amount and type of porosity in the sediment. Porosity may be primary, having been present in the rock since deposition, or secondary, having developed as a result of diagenesis. A classification of porosity types is shown in Fig. F. The terminology of porosity types illustrated here with limestones, is also applicable to sandstones.

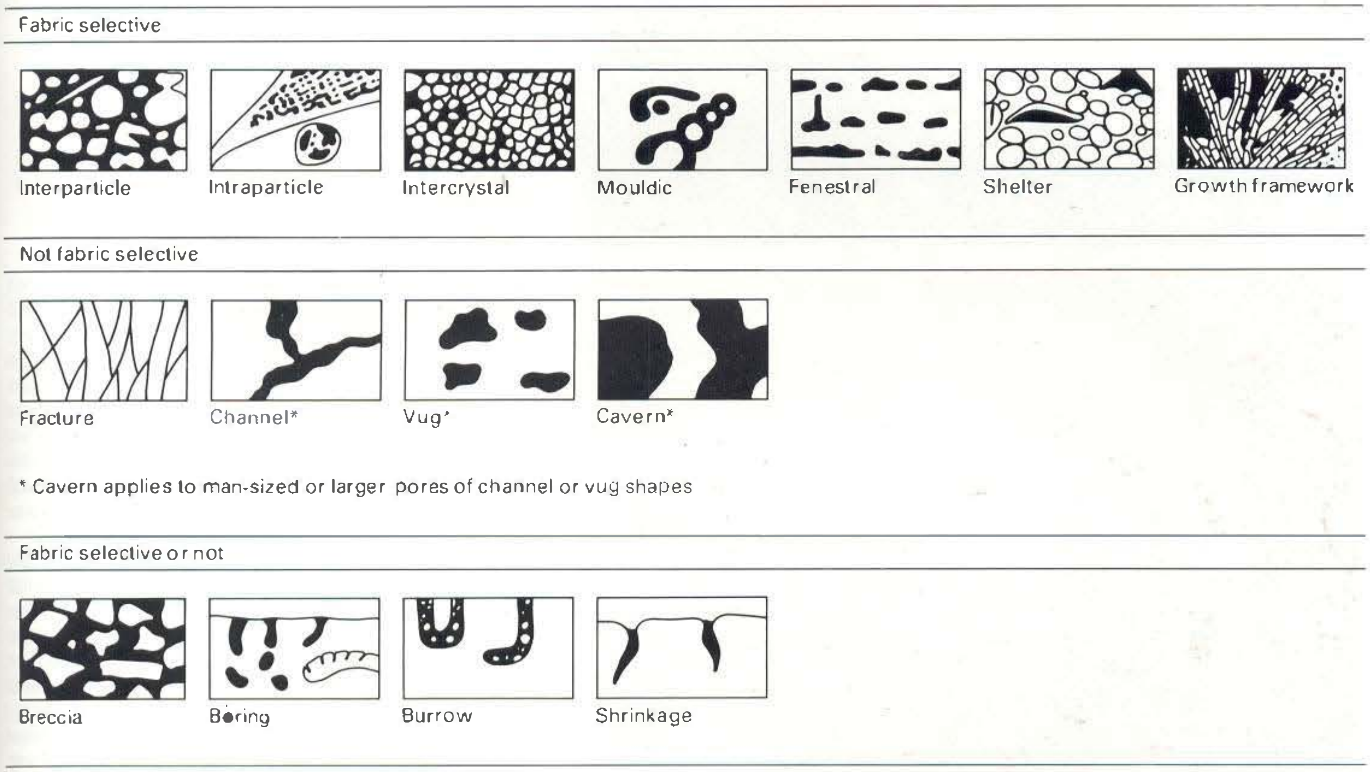
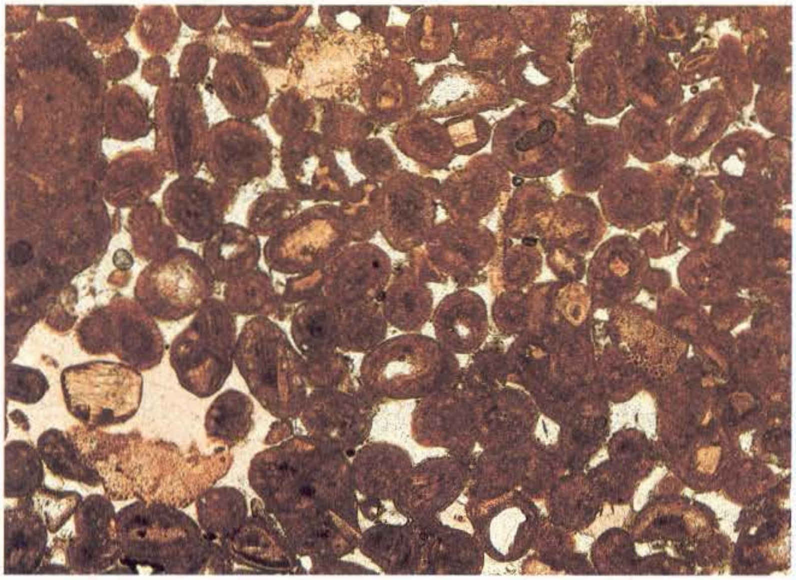
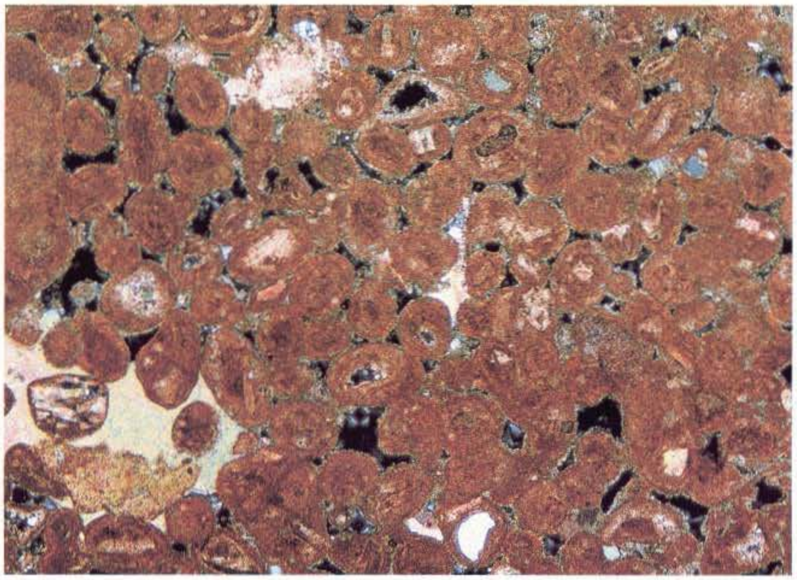


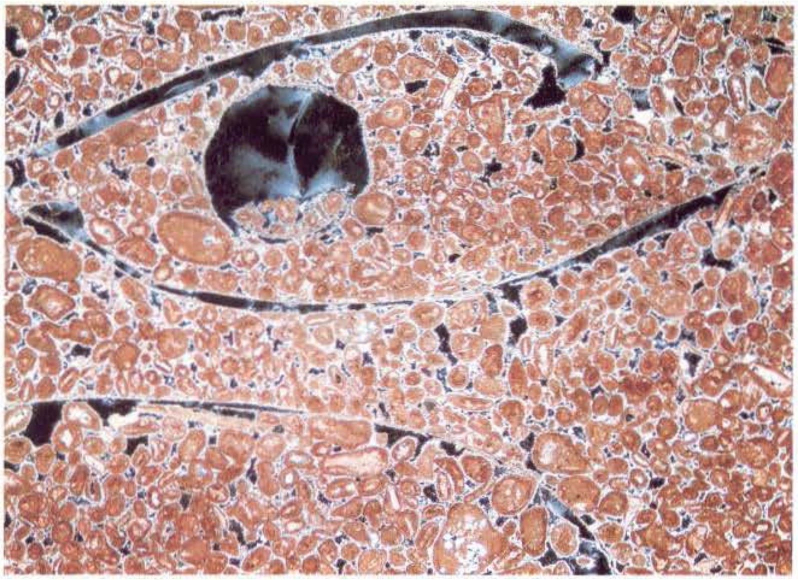
Fig. F Basic porosity types in sediments. Pores shaded black (after Choquette and Pray, 1970)

Limestone porosity

(continued)







151 and **152** show an oolitic/peloidal sediment in which much of the depositional space between grains is unfilled by sediment or cement. The rock is said to show primary *intergranular* porosity. When deposited, such a sediment may have had as much as 50% pore-space. This has been reduced by compaction and by the introduction of some cement. Two types of cement are present – a fine spar, forming coatings on most grains (about ½ mm thick at this magnification and best seen in XPL) and syntaxial overgrowths on echinoderms (lower left). Although localized, the latter are volumetrically more significant.

A common type of secondary porosity is *mouldic* porosity, usually formed by the dissolution of aragonite bioclasts. **153** shows a sediment having primary intergranular and secondary mouldic porosity. Thin micrite envelopes have supported the shell moulds, although that supporting the fragment seen in the lower part of the photograph has partly collapsed.

The bluish-grey interference colours seen in the intergranular pores and the shell moulds of **152** and **153** are caused by strain in the mounting medium.

151 and 152: Stained thin section, Portland Stone, Upper Jurassic, Dorset, England; magnification × 27, 151 PPL; 152 XPL.
153: Stained thin section, Portland Stone, Upper Jurassic, Dorset, England; magnification × 11, XPL.

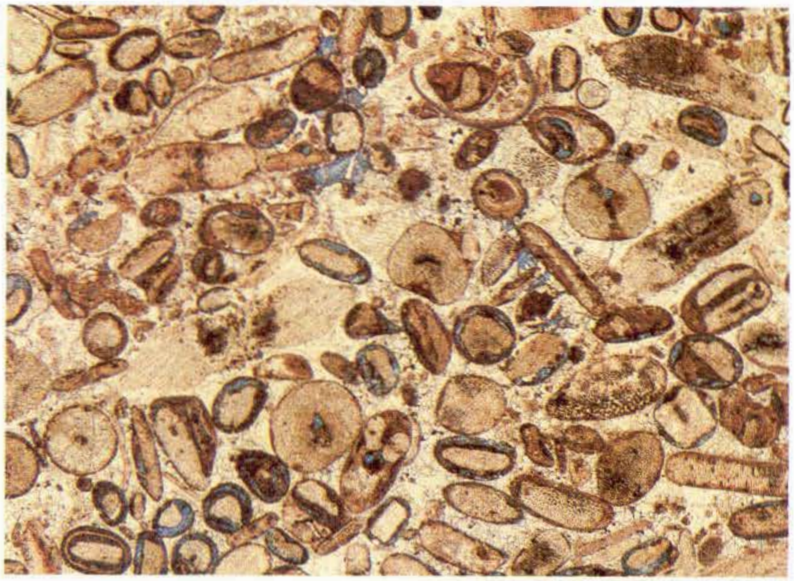
Limestone porosity

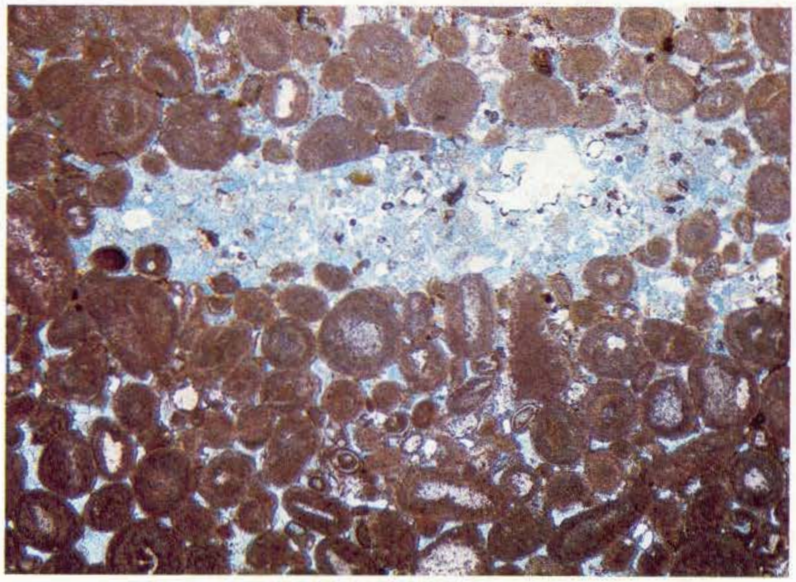
(continued)

154 shows a limestone composed mainly of echinoderm fragments in a pink-stained, non-ferroan, calcite sparite cement. However, a number of grains comprising a small echinoderm fragment nucleus, surrounded by a zone of blue-stained ferroan calcite cement, are also present. This cement is interpreted as a late infilling of pore-space formed by the dissolution of an aragonite coating to the echinoderm fragments. Such a coating is likely to have been oolitic and after solution the sediment would have exhibited *oomouldic* porosity.

Porosity may develop as a result of the burrowing and boring activities of organisms. **155** Shows a section through a boring made by an organism in an oolitic sediment. Note that grains are truncated around the margins of the boring, indicating that the sediment was lithified when the organism was at work and hence the structure is a boring rather than a burrow. The boring is infilled with a ferroan calcite cement, some of which has been lost during the making of the section.

Shelter porosity occurs below curved shell fragments which are preserved in a convex-up position. **156** shows bivalve fragments in a carbonate mud sediment. Those preserved in a convex-up position, including the large fragment extending right across the field of view, have areas of sparite cement below them which was precipitated during the infilling of shelter cavities. Sediment was unable to fill the cavities because of the 'umbrella' effect of the shell.





154: Stained acetate peel, Oolite Group, Lower Carboniferous, Daren Cilau, Llangattock, South Wales; magnification × 15, PPL.
155: Stained thin section, Inferior Oolite, Middle Jurassic, Cooper's Hill, Gloucestershire, England; magnification × 16, PPL.
156: Stained thin section, Lower Carboniferous, Arbigland, Dumfries, Scotland; magnification × 16, PPL.

Limestone porosity

(continued)

Fenestrae is the name used for pores in a carbonate sediment which are larger than grain-supported spaces. They usually become infilled with internal sediment or cement, or a combination of the two. Fenestrae can be different shapes and sizes depending on their mode of origin.

157 shows spar-filled fenestrae in a micrite. Most are irregular in shape and probably formed as a result of the entrapment of fluid in a sediment during desiccation, although the elongated fenestra in the centre may have been a burrow. Fenestrae of this type are sometimes called *birds-eye structures*. The sediment contains a few micrite-walled foraminifera. Fenestral micrites were called *dismicrite* by Folk (see Table 4).

158 shows fenestrae in a fine pellet grainstone. They show a tendency to be elongate parallel to the bedding. Fenestrae of this type are known as *laminoid fenestrae* and may form from the decay of organic matter associated with algal stromatolites (p. 53).

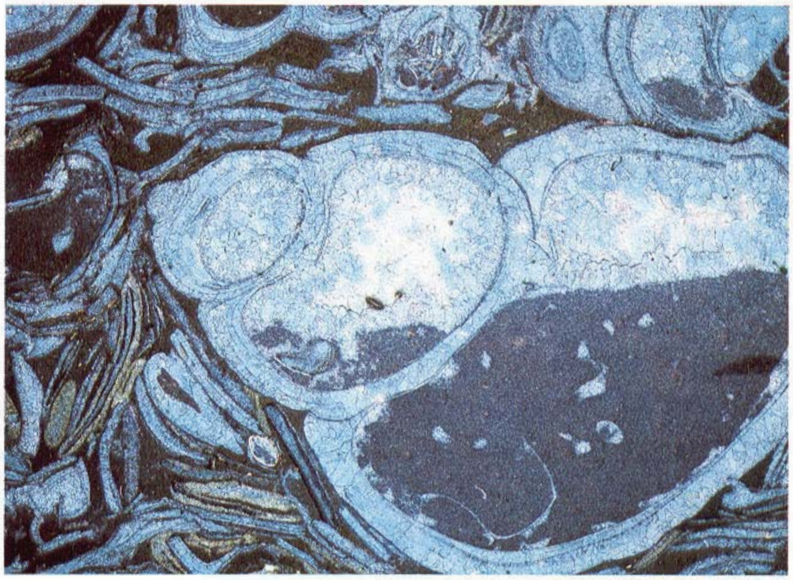
157: Stained thin section, Lower Jurassic, Central High Atlas, Morocco; magnification × 14, PPL.
158: Stained acetate peel, Woo Dale Limestone, Lower Carboniferous, Derbyshire, England; magnification × 7, PPL.

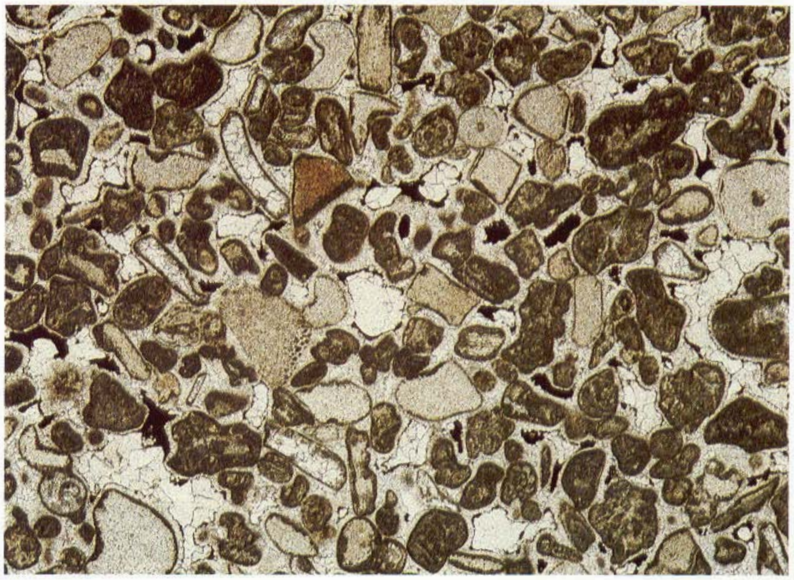
Limestone porosity

(continued)

Pore-space in limestones may be filled with sediment as well as cement. Sediment partially infilling cavities, particularly in fossils or fenestrae, will indicate the horizontal plane at the time of its deposition. Such sediment infills are known as geopetal infills. **159** shows geopetal sediment within a gastropod. On deposition the gastropod would have had a primary porosity within its chambers (*intragranular porosity*). This was partially infilled by micritic sediment and the cavity finally filled by ferroan calcite cement. Inclusions within the shell wall of the gastropod and surrounding bioclasts suggest that they inverted to calcite during neomorphism (p. 61), rather than being cement-filled casts.

Some pore-spaces have hydrocarbons within them or have evidence that hydrocarbons have passed through. **160** shows a limestone in which a few pores are filled with black hydrocarbon and others are lined by a thin coating of it. Examination of its relationship to the cement shows that the hydrocarbon entered the rock after an early generation of isopachous cement (marine?) and before the final filling of coarse blocky cement (meteoric).





159: Stained thin section, Purbeck Marble, Upper Jurassic, Dorset, England; magnification × 12, PPL.
160: Unstained thin section, Bee Low Limestone, Lower Carboniferous, Windy Knoll, Derbyshire, England; magnification × 16, PPL.

Source :Tucker - Sedimentary Rocks in the Field (3rd edition)