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# FISSURE DEVELOPMENT IN THE COTSWOLDS

R.V. Davis

The majority of speleologists and mine exploration enthusiasts tend to concentrate their attentions on the Carboniferous Limestones for the former, and known metal lodes for the latter. This of course is natural as these are where one would expect to locate major developments, and. where exploration, research and optimum results could be achieved.

However, all subterranean features are, by no means restricted entirely to these two categories, as this brief article hopes to illustrate.

The area under consideration is the Dursley district of Gloucestershire. Topographically the district is situate on the west-facing scarp, edge of the Mid-Cotswold Hills, being of Mesozoic sediments representative of the Upper Lias and Oolithic series of the Jurassic system.

A section through the scarp, reveals the following stratigraphical succession. Lower Lias Clay, Middle Lias, Marl, Uppe~ Lias Clay, Cotteswold Sands, Oolite Inferior.

This shows a varied sediment lithology, resting on the Blue Clay of the Lower Lias. Extensive work has been carried out for many decades on the sub-divisions of Mid-Jurassic sediments, (Arkell and Donovan 1952). Kellaway and Welch 1961. Martin 1967). Using zonal ammonites, lamellibranchs and echinoderms, and the depositional sequence, and facies changes are quite well understood.

The general disposition of the Cotswold strata is a dip 2-4 degrees E. and S.E. This, however, is of little consequence in the area under question, as much stratigraphical dislocation occurs, caused by the weight of the brittle Inferior Oolitic sediments above, resting on the incompetent Blue Lias Clay. This causes the Inferior Oolite to slump over the Scarp edge, being a direct consequence of perglacial solifluction of the Lias Clays. The jointing pattern thus created in the Oolite sediments has been admirably described by Hancock (1969), who recognises three pairs of systematic joints in the area, viz. conjugate pair J1 striking N.E. to S.W. and J2 striking N.W. to S.E., making a mean dihedral angle of 82 degrees about their E/W bisectrix; orthagonal pair J3 striking N. to S. and pair J5 and J6 of relative unimportance.

The magnitude of the joint is determined by its orientation to the [38] axis of the scarp and the lithoidal character of the particular horizon in which it is located. In general these joints occurring in a more compact sediment are best developed. Horizons which are more pisolitic in character exhibit poorer quality joints, as the loosely consolidated sediment, with randomed spaced cracks occurring in these strata, tend to dissipate stress adequately.

Many of the joints are found to be infilled with calcite, especially those of the J1, J2 suite. Evaporation levels of juvenile water which part1y filled the joints are marked by calcite bands running parallel along both face of the joints in many cases. By measuring the declination of these bands to the horizontal, it is possible to calculate the degree of movement of the strata. Where these still lie parallel to the horizontal, no slumping has taken place.

Complimentary groups of calcite bands can also indicate whether the joint occupies a fault plane and in some cases normal faulting up to 3 metres displacement occurs.

Two joints are of sufficient magnitude to be worthy of speleological report. Being nameless they are referred to here as Uley Fissure, O.S. 1 inch Sheet 156, N.G.R. 787.996, and Dursley Fissure at 751.979. Uley Fissure lies approximately at right angles to the scarp edge. A small entrance (1 x ½ metre) gives access to an extended fissure type cave as shown on the sketched plan and elevation. Detailed survey results of the ‘cave’ are not yet complete as the final pitch has not been completely descended, a vertical depth of 12 metres having so far been attained. Depositional calcite formations can be conveniently classified into (i) parallel, horizontal (as mentioned previously), (ii) abandoned encrustation and (iii) recent active stalactitic deposits and dripstone. There is suggestion that the gentle folding of the Cotswolds took place in mid-Tertiary times, thus age relationship can be equated with group (i) deposition. The group (ii) abandoned encrustations are in places fractured up to a width of 1.5 cm. and show release of more recent pressures.

The character and form of these minor fractures perhaps. best of all illustrate the fracture, coefficients of the lithoidal facies encountered. The supposed strata traversed in descending order is Upper Aglenian Freestone, Marl, Lower Limestone, Cephalapod Bed, Cottswold Sands, but the local facies changes make this correlation rather difficult.

Dursley Fissure is formed in a slightly lower stratigraphical horizon than Uley Fissure, having a roof in the Lower Freestone and a base somewhere near the Upper Lias Cephalopod Bed, although this horizon may be a non sequence here, as thin sections from the lower reaches of each fissure seem to suggest a level in the Cotswold Sands. [39] Here, underground progress is prevented by a roof fall after some 18 metres. These fissures therefore could be stated as being superficially dilated structures of tectonic origin, still in an active state of extension, being slowly modified by aggressive ground waters.

Directly related to the structure and topography, is the drainage of ground water. This important factor plays a major role both in enlarging existing fissures by solution, and correlating the tectonic sequence by calcite infilling of fissures.

To obtain a fuller understanding of the inter-relationship of the drainage and jointing patterns, work continues at Balls Green Lower Mine (867.995) where Greater Oolite Freestone has been worked for building stone. The works afford unrivalled access to study the behaviour of joints below surface level, and to observe variations in the volume and time interval between precipitation and underground flow, and water analysis of pH and Ca. content of the waters.

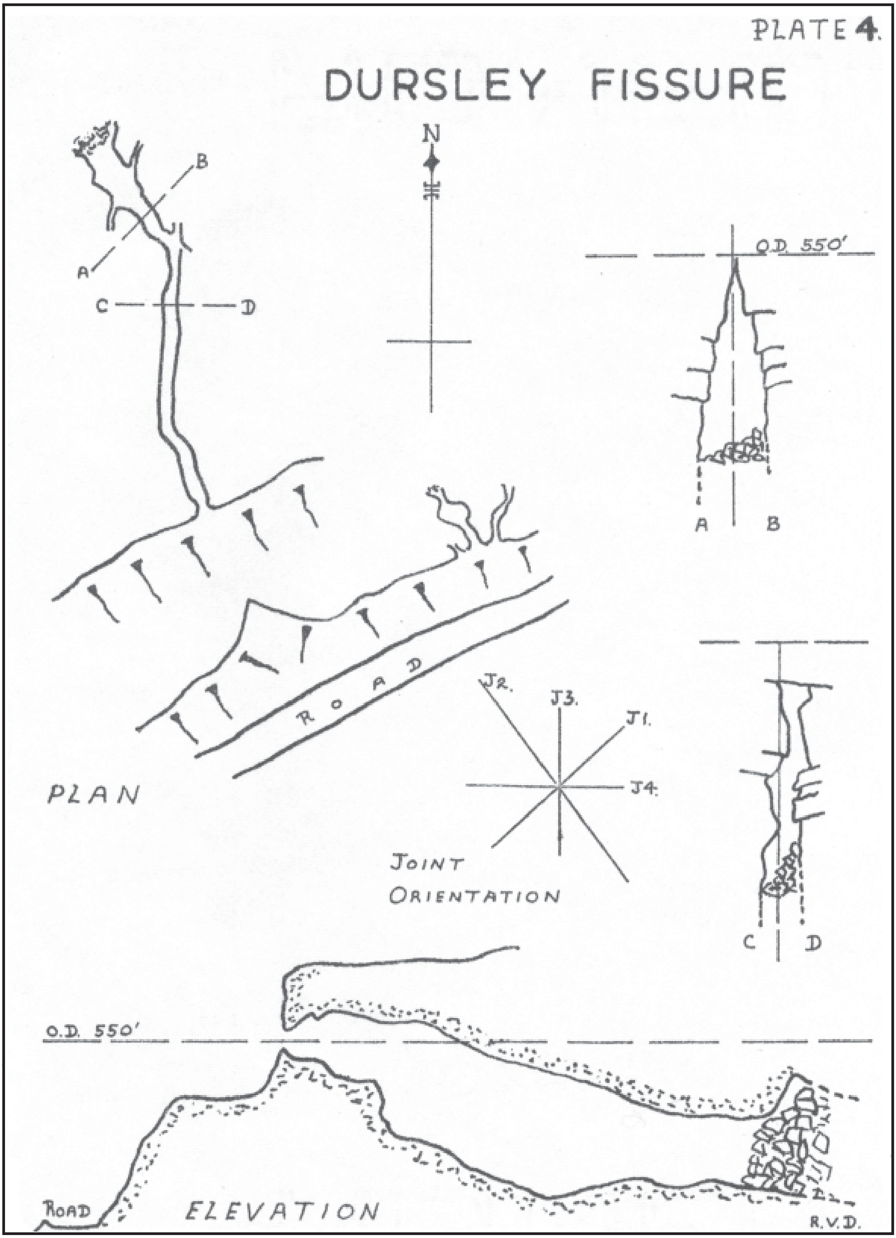
PLATE 4.
DURSLEY FISSURE
N
B
A
C
D
O.D. 550'
A
B
C
D
ROAD
J2.
J3.
J1.
J4.
PLAN
JOINT
ORIENTATION
O.D. 550'
ROAD
ELEVATION
R.V.D.

An experiment, whereby stalactites were grown under controlled conditions in a laboratory from solutions of known concentration, also furnishes additional data concerning unit growth, crystal relationship and wt. deposited c.c. evaporated at x degrees centigrade. It is too early to draw any meaningful conclusions applicable to the depositional features encountered in the natural fissures. However, as a pattern emerges, several interesting problems arise in interpreting the field evidence. General observations indicate that the majority of parallel calcite bands located at sites within the Lower Inferior Limestone contain a predominance of scalenohedral (2131) with prism variations. Simple contact twins occur infrequently. This form would appear to have crystallized from a near saturated solution, and tends to form the first phase in calcite deposition. The rhombohedral hexagonal form (1011) tends to signify a more ‘evaporate’ secondary encrustation sometimes on top of the scalenohedrons, occurring in both J1/J2 and J3/J/4 joints suggest a greater age and may have been modified by semi phreatic/vadose action Possibly during a pre-glacial period when temperatures would have been sufficiently high to allow crystallization to occur.

NOTE: The limestones may be current bedded and Oolitic structured, often grossly deformed by recrystallization, creating additional stress, which causes the rock to expand. Detrital quartz particles form the nucleus for ooliths, but occasionally small limonite stained fragments are also found. The cementing agent consists of a matrix of calcarious marl.

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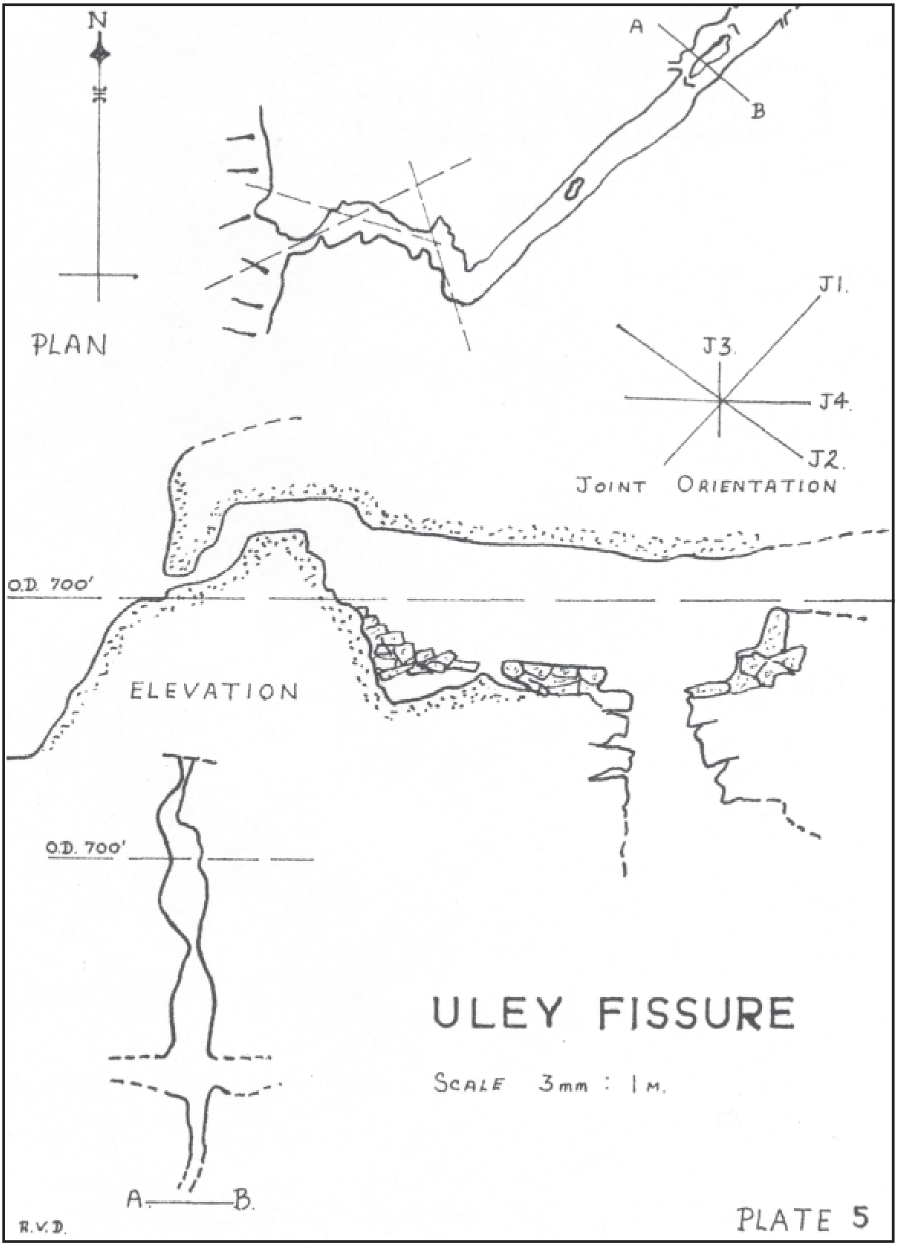
N
A
B
PLAN
J1.
J3.
J4.
J2.
JOINT ORIENTATION
O.D. 700'
ELEVATION
O.D. 700'
ULEY FISSURE
SCALE 3mm : 1M.
A. B.
R.V.D.
PLATE 5