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1986/34. Petrography and palaeoenvironments of some Permian coals, Nicholas Range, north-eastern Tasmania.

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Abstract

On the Nicholas Range in north-eastern Tasmania the Lower Freshwater Sequence (LFS) of the Parmeener Super-Group rests directly on basement with no intervening Lower Marine Sequence.

The LFS is equivalent to the Mersey and Preolenna Coal Measures which occur further west.

Thin coal seams near the base and near the top of the LFS on the Nicholas Range are composed of bright coal, low in ash with a high energy value and a high sulphur content.

The coals formed in a wet, relatively treeless environment, probably in a lagoonal area behind a barrier beach. The environment was subject to paralic influence.

INTRODUCTION

While mapping Lower Parmeener Super-Group rocks in the St Marys Quadrangle (Turner et al., 1984), one of the authors (C.R.C.) noted the occurrence of several thin coal seams in the Lower Freshwater Sequence along the north side of the Nicholas Range [EQ930000]. Although too thin and laterally discontinuous to be of economic interest, the three thickest seams were sampled and subjected to proximate and petrographic analysis, for comparative purposes. Two seams near the top of the Lower Freshwater Sequence were sampled in Catos Creek [EQ970028], and one seam near the base in nearby Huntsmans Creek [EQ945025].

Parmeener Super-Group geology of the area is described in detail in Calver (1986).

STRATIGRAPHY

The Lower Parmeener Super-Group is well-exposed in numerous creeks along the north flank of the Nicholas Range, and continues in the subsurface to the south. Basement is high relative to the rest of Tasmania, and the Lower Freshwater Sequence rests directly on basement with no intervening Lower Marine Sequence. The Huntsmans Creek section (fig. 1) occupies a local basement trough between a pronounced high centred on EQ991018, five kilometres to the east, and a gentler basement high to the west. On the summit of the eastern basement high, the Upper Marine Sequence overlaps the Lower Freshwater Sequence and rests directly on basement. The Catos Creek section (fig. 1) is situated on the western flank of this feature. South-trending palaeocurrents suggest that the trough continues and deepens to the south in the subsurface.

The Lower Freshwater Sequence on the Nicholas Range is laterally variable but in relatively complete sections, typically consists of (1) basal, impersistent coarse conglomerate and breccia, succeeded by (2) cross-bedded coarse to medium-grained quartzarenite, (3) fine quartzarenite, often with ripple cross-lamination, (4) siltstone and

TOP OF LOWER FRESH-WATER SEQUENCE ?

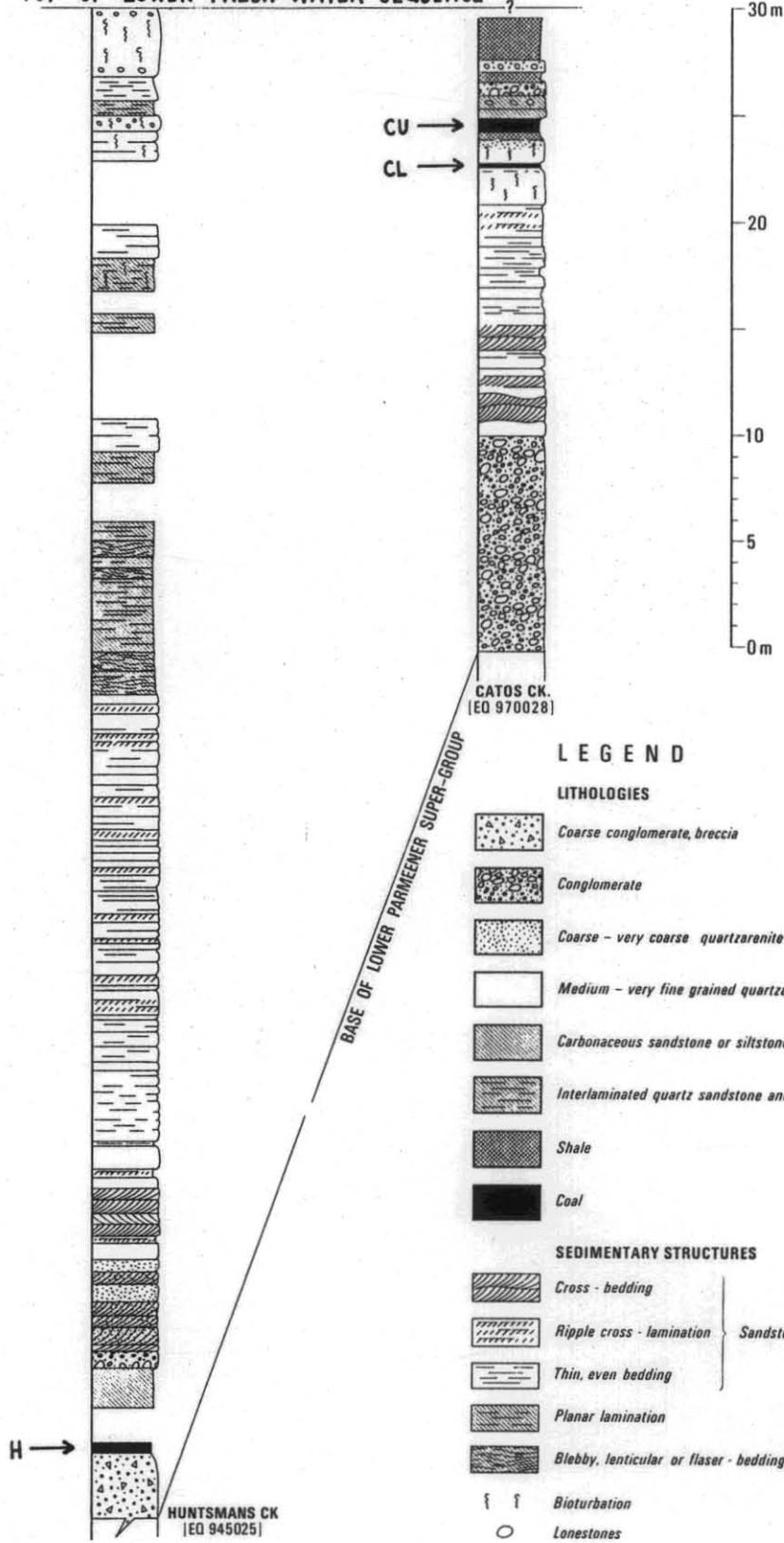


Figure 1. Sections through the Lower Freshwater Sequence.

carbonaceous shale, usually interlaminated to produce flaser-bedded or parallel-laminated intervals, slightly bioturbated and with rare limestones near the top, and (5) a unit of massive, thoroughly bioturbated, sparsely pebbly sandstone with rare marine fossils, at the top of the sequence. This is followed by poorly-sorted mudstones and sandstones with marine fossils of the Upper Marine Sequence.

PALAEOENVIRONMENTS

In the Nicholas Range area, palaeocurrents in the cross-bedded quartzarenites are strongly unimodal at any one locality but have a regional pattern showing diversion around the basement highs, with an overall southward direction (Calver, 1986). These sandstones were probably laid down in a low-sinuosity fluvial system that waned in competence with rising base-level. The fine-grained ripple-marked quartz sandstones were succeeded by probably intertidal, then shallow-marine environments, represented by the flaser-bedded shales and bioturbated sandstones, respectively. The rarity of preserved shelly benthos, in conjunction with the abundant infauna, suggest that brackish conditions prevailed at the conclusion of Lower Freshwater Sequence sedimentation.

The marine parts of the Lower Parmeener Super-Group contain well-documented evidence for cold climatic conditions, but no evidence for sub-zero temperatures (e.g. ice-wedge pseudomorphs) is yet known from the non-marine beds.

The coal seams sampled in Catos Creek are near the top of the Lower Freshwater Sequence, and are interbedded with black shale and bioturbated fine-grained sandstone, and overlain by carbonaceous, sparsely-pebbly fine-grained sandstone. The coal is bright and massive, with a well developed closely-spaced cleat, and is free of clastic impurities and dirt bands. Some pyrite can be seen on cleat faces. No *in situ* plant material (root traces, etc.) has been seen. Thin coal seams are quite common at about this horizon elsewhere on the Nicholas Range. A restricted paralic environment of deposition is probable for these coals.

The environment of the seam in Huntsmans Creek is uncertain. Here, the coal directly overlies about 3 m of basal rudite. Immediately above the unconformity is a massive, poorly-sorted, clast-rich, open-framework breccia-conglomerate derived wholly from Mathinna Beds, with clasts up to 0.3 m in diameter. This grades upwards into a somewhat finer conglomerate with a lesser proportion of clasts and an unusual black, richly carbonaceous sandy matrix. This bed forms a broad waterworn pavement below the coal seam exposure. The conglomerate grades up into the coal, which is pebbly at the base but otherwise appears similar to the coal in Catos Creek. The seam is succeeded (after a gap in outcrop) by grey, slightly carbonaceous, fine-grained quartz sandstone, followed by conglomerate and cross-bedded quartzarenite. No similar development of carbonaceous rocks at the base of the Lower Freshwater Sequence is known anywhere else in the St Marys Quadrangle.

The Lower Freshwater Sequence is anomalously thick (~70 m) at Huntsmans Creek. At the Douglas River, for example, south of the St Marys Quadrangle, the Lower Freshwater Sequence is not attenuated by high basement and is 56 m thick (Calver *et al.*, 1984). It is therefore possible that the basal coal-bearing beds at Huntsmans Creek were also

deposited under paralic conditions, at the conclusion of Lower Marine Sequence sedimentation.

GEOLOGY

Whole seam channel samples from the three seams (labelled H, CL and CU on Figure 1) were collected and subjected to proximate and petrographic analyses. The results are given in Tables 1-2, and Figures 2-4.

The coals are low in ash (around 10%) with high specific energy (~ 29 MJ/kg) and a high sulphur content (3%). The seams are all less than one metre thick (CL: 0.2 m; CU: 0.6m; H: >0.4 m (top not exposed)). The coals are very clean with a low percentage of mineral matter ($<5\%$).

COAL PETROGRAPHY

Petrographically the coals are characterised by high proportions of both vitrinite (40-50%) and exinite (15-25%). The vitrinite is mainly in the form of desmocollinite with only a third or less of the vitrinite being telinite or telocollinite. The exinite is mainly sporinite, although the Lower Seam in Catos Creek (CL) contains some 17% alginite, indicating that this coal swamp was flooded for all or part of the peat formation. The vitrinite and exinite content of these Early Permian coals is significantly higher than that of the Late Triassic coals and the inertinite component is correspondingly lower.

The inertinite content of the Early Permian seams is composed almost entirely of equal quantities of semifusinite and inertodetrinite.

Table 1

PROXIMATE ANALYSES, LOWER PERMIAN SEAMS, NICHOLAS RANGE

| | Catos Creek Upper Seam (CU) | Catos Creek Lower Seam (CL) | Huntsmans Creek Seam (H) |
|---------------------------|-----------------------------------|-----------------------------------|--------------------------------|
| <i>Air-dried basis</i> | | | |
| Moisture (%) | 3.6 | 4.6 | 4.3 |
| Ash (%) | 8.8 | 11.1 | 10.1 |
| Volatile matter (%) | 40.3 | 40.1 | 48.9 |
| Fixed carbon (%) | 47.3 | 44.2 | 36.0 |
| Total sulphur (%) | 3.75 | 2.41 | 2.91 |
| Specific energy (MJ/kg) | 29.36 | 27.88 | 29.60 |
| <i>Dry ash-free basis</i> | | | |
| Volatile matter (%) | 46.0 | 47.6 | 57.1 |
| Specific energy (MJ/kg) | 33.52 | 33.08 | 34.58 |

Table 2

MACERAL ANALYSES, LOWER PERMIAN SEAMS, NICHOLAS RANGE

| | Catos Creek Upper Seam (CU) | Catos Creek Lower Seam (CL) | Huntsmans Creek Seam (H) |
|-------------------|-----------------------------------|-----------------------------------|--------------------------------|
| <i>VITRINITE</i> | (53) | (41) | (42) |
| Vitrinite A | 18.6 | 8.3 | 9.1 |
| Vitrinite B | 34.0 | 33.3 | 32.6 |
| <i>EXINITE</i> | (13) | (25) | (14) |
| Sporinite | 9.6 | 2.6 | 7.6 |
| Cutinite | 2.0 | 2.3 | 4.0 |
| Resinite | 1.3 | 3.3 | 3.0 |
| Alginite | - | 16.6 | - |
| <i>INERTINITE</i> | (32) | (30) | (39) |
| Micrinite | 1.6 | 2.0 | 2.6 |
| Macrinite | 0.3 | 1.0 | 2.6 |
| Semifusinite | 15.6 | 12.0 | 15.3 |
| Fusinite | 1.3 | 2.3 | 3.0 |
| Inertodetrinite | 13.3 | 12.3 | 15.0 |
| <i>MINERALS*</i> | 2.1 | 4.0 | 4.6 |

* Clay, quartz, pyrite.

REFLECTANCE (mean maximum)

| | | | |
|-------------------|------|------|------|
| Vitrinite A | 0.56 | 0.46 | 0.52 |
| Vitrinite B | 0.51 | 0.45 | 0.47 |
| Vitrinite A and B | 0.53 | 0.45 | 0.48 |

COAL FACIES

An examination of the ratios of various macerals in coals can be used to define coal facies. The procedure outlined by Diessel (1986) for delineating Gelification and Tissue Preservation Indices was followed to define the coal facies of the three seams.

The Gelification Index compares macerals which are formed in wet and dry environment. Similar source material may produce quite different macerals in differing conditions of peat formation. Wet conditions, usually associated with fast subsidence, will produce gelified residual tissue, (telinite and telocollinite) while under conditions of slow subsidence a drier environment is more likely and the tissue products may become fusinitised, producing fusinite and semifusinite. The ratio

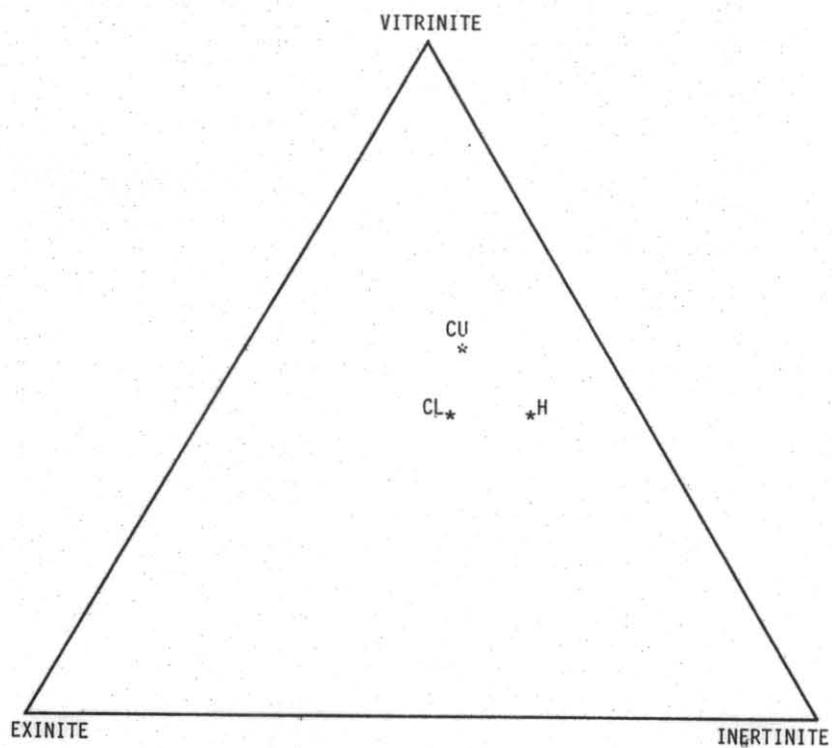


Figure 2. Petrographic composition of the Early Permian seams, Nicholas Range.

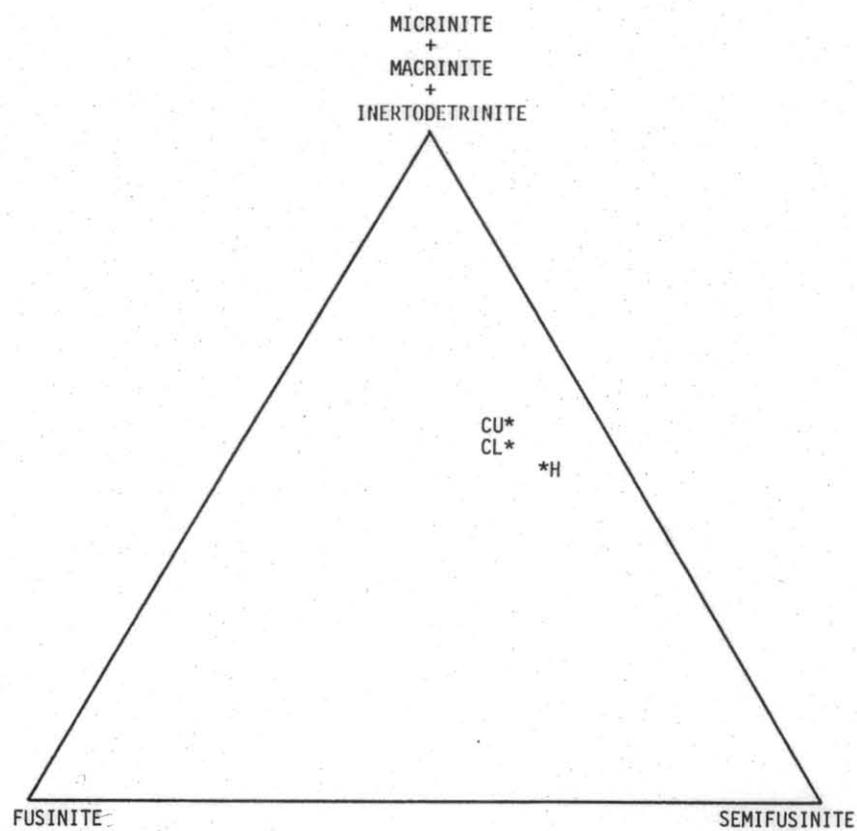


Figure 3. Inertinite composition of Early Permian seams, Nicholas Range.

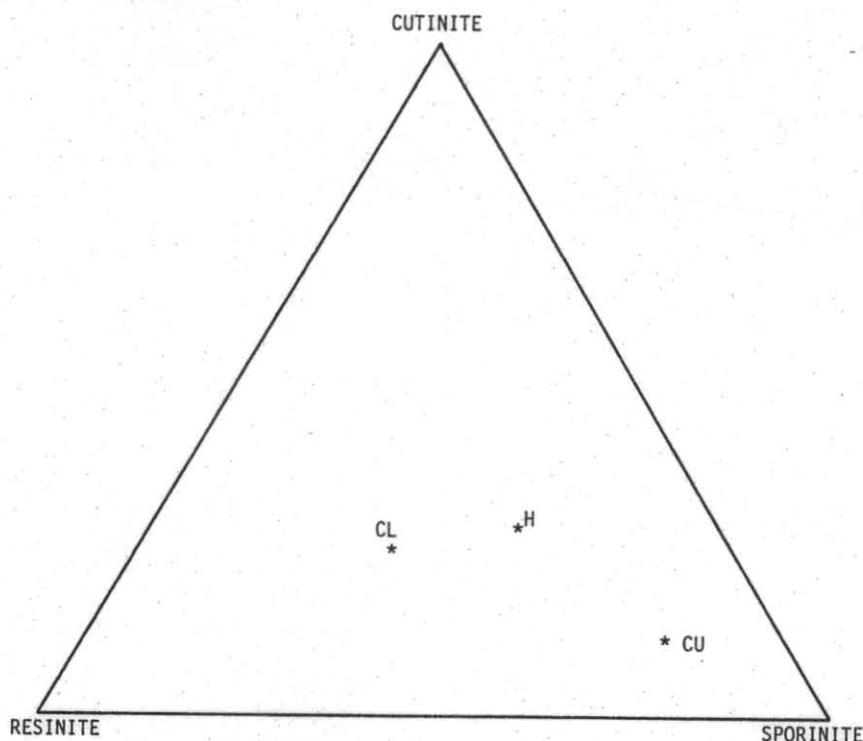


Figure 4. Exinite composition of the Early Permian Seams, Nicholas Range.

between these two groups of macerals can be used as an indication of the level of moisture in the peat swamp.

$$GI = \frac{\text{vitrinite} + \text{macrinite}}{\text{fusinite} + \text{semifusinite} + \text{inertodetrinite}}$$

The Tissue Preservation Index compares macerals which are derived from woody tissue (telinite and telocollinite in wet habitats, fusinite and semifusinite in dry habitats) can be combined and contrasted with macerals derived from the destruction of cell tissue, to give a measure of the amount of wood to non-wood derived material in a coal.

$$TPI = \frac{\text{telinite} + \text{telocollinite} + \text{fusinite} + \text{semifusinite}}{\text{desmocollinite} + \text{macrinite} + \text{inertodetrinite}}$$

These two indices may be used together to define coal facies. The facies for the Early Permian seams and some Late Triassic coals are shown in Figure 5. The Early Permian coals have high Gelification Indices, indicating a wet environment of deposition and a very low Tissue Preservation Indices, showing that the peat formed in a habitat which did not produce significant quantities of woody tissue. These coals probably formed in an open moor habitat, and marine influence is indicated by a high pyrite content. The TPI and GI values are similar to the Greta, Melville and Wynn seams of N.S.W. which are considered by Diessel (1986) to have been formed in paralic environments.

The Greta seam is thought to have formed on a defunct delta plain in front of the invading sea, while the Melville and Wynn seams may have formed in a back barrier environment (Diessel, 1986).

The Lower Freshwater Sequence on the Nicholas Range was deposited on a residual basement high and was followed by marine sedimentation.

The three seams examined formed in a wet, relatively treeless environment which was submerged or extremely wet, as suggested by the presence of alginite and the abundance of sporinite as spores collect in ponds. A back barrier environment with paralic influence is suggested as the environment of coal formation of these three seams.

Contrasting with this environment is the dry terrestrial moor habitat in which the Late Triassic seams formed.

CONCLUSIONS

The early Permian coals of the Lower Freshwater Sequence on the Nicholas Range are low ash, high sulphur, high energy coals. The seams are thin (<1.0 m thick) and of restricted lateral extent. The Lower Freshwater Sequence is deposited directly onto basement in this area, and is directly overlain by the Upper Marine Sequence.

The coals are thought to have been deposited in a back barrier environment which was subject to paralic influence.

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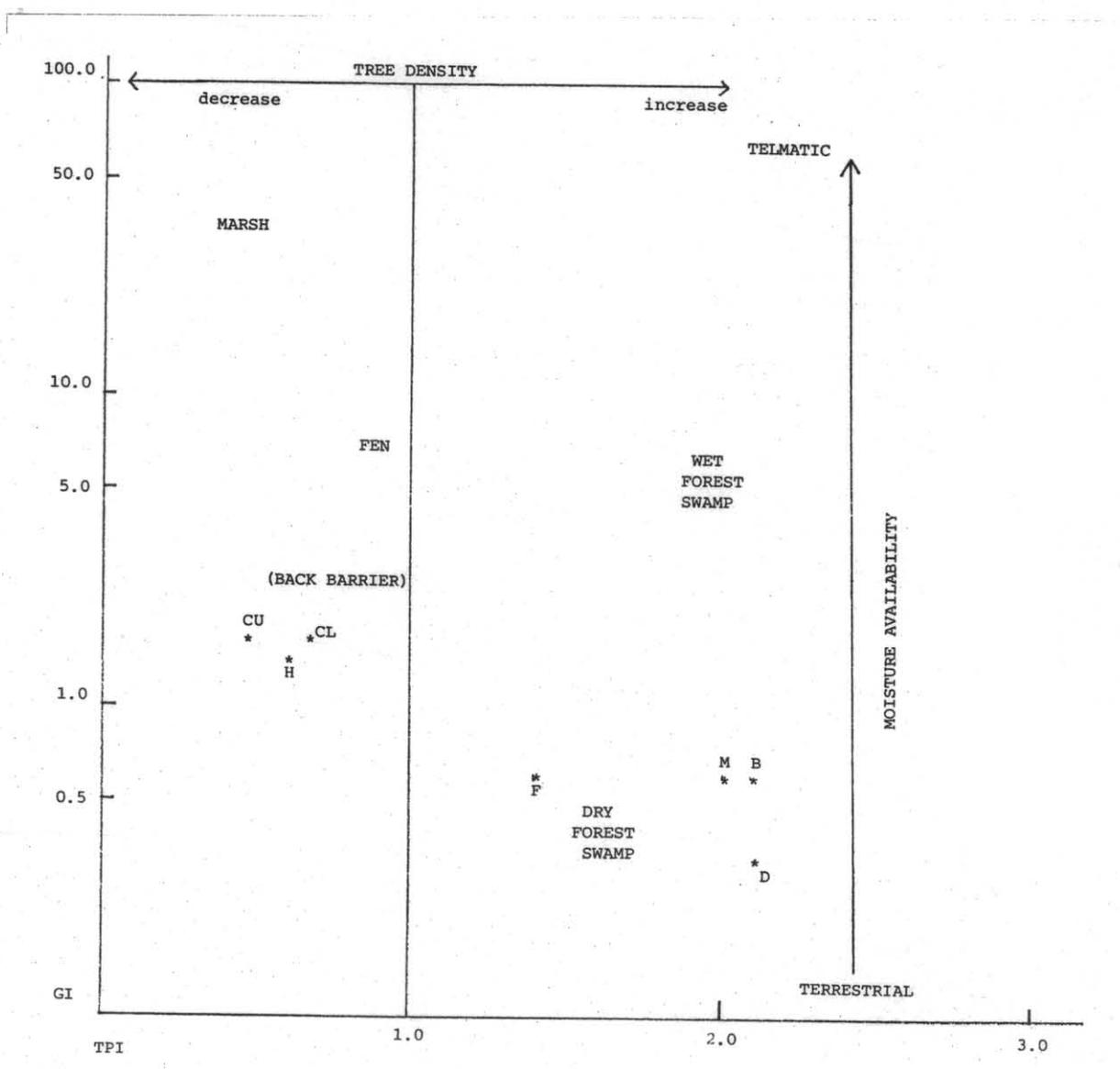
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[23 June 1986]



EARLY PERMIAN SEAMS

- CU = CATOS CREEK UPPER
- CU = CATOS CREEK LOWER
- H = HUNTSMANS CREEK

LATE TRIASSIC SEAMS

- D = DUNCAN
- B = BLUE
- M = MERRYWOOD
- F = FENTON

