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Early Carboniferous (Early Viséan – Serpukhovian) Palynomorphs

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Well preserved assemblages of Early Carboniferous miospores have been recovered from a number of wells including A1–NC92, A1–37, A1 A–84, B1–2, G1–82, B1–14 and J1–81A. In some cases the palynomorph assemblages are quantitatively sparse and frequently show evidence of reworking of Late Devonian forms. A series of readily indentifiable palynological events have been established from examination of Wells J1–81A, A1–NC92, A1–14, A1–37 and A1 A–84. The oldest miospore assemblage has been recognised in Well A1–37 in the interval 7914 to 8185 ft. and in the lowest part of Well A1–NC92 above 9623 ft. and is characterised by abundant *Spelaeotriletes balteatus* occurring together with *S. owensi, Radiizonates genuinus* and *Vallatisporites agadesi*. The assemblage is supplemented in the lower part of the interval by *Spelaeotriletes pretiosus* and *Vallatisporites vallatus*. This association is considered to be no older than Early Viséan. Assemblages containing *Spelaeotriletes pretiosus* and *Vallatisporites vallatus* from the Rhadames Basin in western Libya (Massa *et al.*, 1980) were considered to be Tournaisian age but the abundance of *Spelaeotriletes balteatus* in the present samples strongly suggests an earliest Viséan age to be more probable. Tournaisian sediments probably occur in some of the wells but the poor state of preservation together with problems of reworking do not at the present time permit them to be positively identified palynologically.

The second association which is recognised in Well A1–NC 92 in the interval 8900 to 9623 ft., in Well J1–81A and in the lowest part of Well A1–14 is distinguished by the appearance of representatives of the genus *Lycospora* and *Spelaeotriletes triangulus*. The appearance of these forms more or less coincides with the tops of the ranges of *Radiizonates genuinus, Spelaeotriletes balteatus, S. owensi* and *Vallatisporites agadesi*. Broadly similar distribution patterns were observed in the Rhadames Basin which were dated as Late Viséan (Collenia Unit = V_3c) and the Early Serpukhovian. Representatives of *Foveosporites appositus, Tricidarisporites serratus* and *Waltzispora planiangulata* are frequently accessory components in this assemblage.

The third and youngest association recorded in Well A1–NC92 in the interval 8115 to 8920 ft. and in Well A1–14 in the interval 7910 to 8400 ft., is characterised by the appearance of monosaccate pollen. In the Rhadames Basin the latter were identified for the first time in the *Eostaffelina* and *Eosigmolina* Biozone (Massa & Vachard, 1979) which is equivalent to the Protvian which in turn corresponds with the early part of the Late Serpukhovian. In Australia, Kemp *et al.*, 1977 have found these monosaccates appearing for the first time at the base of the *Anabaculites yberti* Assemblage Zone, which has been dated independently by conodonts and ostracods (Jones *et al.*, 1973) as Early Namurian and by its occurrence with the *Echinochonchus gradatus* Brachiopod fauna of Roberts (1971) as Late Viséan or Early Namurian.

The interval characterised by this assemblage is therefore attributed to the Serpukhovian.

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Explanation of Plate 33

All figures are × 500

Fig. 1. *Punctatisporites* cf. *glabrimarginatus* Owens, 1971. A1A–84, 5180ft., Slide 1, L31/1, AGC 789. (Frasnian–Viséan).

Fig. 2. *Punctatisporites planus* Hacquebard, 1957. A1A–84, 5180ft., Slide 1, P39/1, AGC 790.

Fig. 3. *Punctatisporites irrasus* Hacquebard, 1957. A1A–84, 5060ft., Slide 1, U30/1, AGC 791.

Fig. 4. *Retusotriletes crassus* Clayton *in* Clayton *et al.*, 1980. A1A–84, 5780ft., Slide 1, Y37/1, AGC 792. (Early Carboniferous).

Fig. 5. *Anapiculatisporites tersus* Playford, 1964. J1–81A, 9440–9470ft., Slide 1, U39/1, AGC 793.

Figs. 6, 7. *Waltzispora polita* (Hoffmeister, Staplin & Malloy) Smith & Butterworth, 1967. Fig. 6, J1–81A, 8570–8610ft., Slide 1, W37/3, AGC 794. Fig. 7, J1–81A, 8570–8610ft., Slide 1, Z39/4, AGC 795.

Fig. 8. *Umbonatisporites* cf. *distinctus* Clayton, 1970. A1–37, 8185ft., Core 13, S.G. 8185/25, AGC 796.

Fig. 9. *Apiculiretusispora multiseta* (Luber) Butterworth & Spinner, 1967. A1–37, 8162ft., Core 13, S.G. 8162/88, AGC 797. (Early Carboniferous).

Fig. 10. *Granulatisporites granulatus* Ibrahim, 1933. J1–81A, 8570ft., Slide 1, Z33, AGC 798.

Fig. 11. *Anapiculatisporites concinnus* Playford, 1962. J1–81A, 9140–9180ft., Slide 1, P37, AGC 799.

Fig. 12. *Tricidarisporites dumosus* (Staplin) Sullivan & Marshall, 1966. B1–2, 12200–300ft., Slide 1, E32/0, AGC 800. (Viséan–Namurian).

Fig. 13. *Convolutispora* sp. A. A1–37, 8150ft., Core 13, S.G. 8150/32, AGC 801.

Fig. 14. *Pustulatisporites* sp. A. A1A–84, 5520ft., Slide 1, W37/1, AGC 802.

Fig. 15. *Foveosporites appositus* Playford, 1971. J1–81A, 9140–9180ft., Slide 1, V33/3, AGC 803.

Fig. 16. *Pustulatisporites* cf. *gibberosus* Hacquebard, 1957. A1–37, 8162ft., Core 13, S.G. 8162/13, AGC 804.

Fig. 17. *Verrucosisporites nitidus* (Naumova) Playford, 1963. A1–37, 8145ft., Core 13, Slide 1, P40/2, AGC 805. (Famennian–Viséan).

Fig. 18. *Convolutispora stigmoidea* Bharadwaj & Venkatachala, 1961. A1A–84, 5340ft., Slide 1, S55/0, AGC 806.

Fig. 19. *Convolutispora* cf. *mellita* Hoffmeister, Staplin & Malloy, 1955. A1–37, 8131–32ft., Core 13, S.G. 8131–8132/56, AGC 807.

Fig. 20. *Convolutispora circumvallata* Clayton, 1970. A1–37, 8162ft., Core 13, Slide 1, P41/1, AGC 808.

Fig. 21. *Dictyotriletes* sp. A. A1A–84, 5180ft., Slide 1, U38/0, AGC 809.

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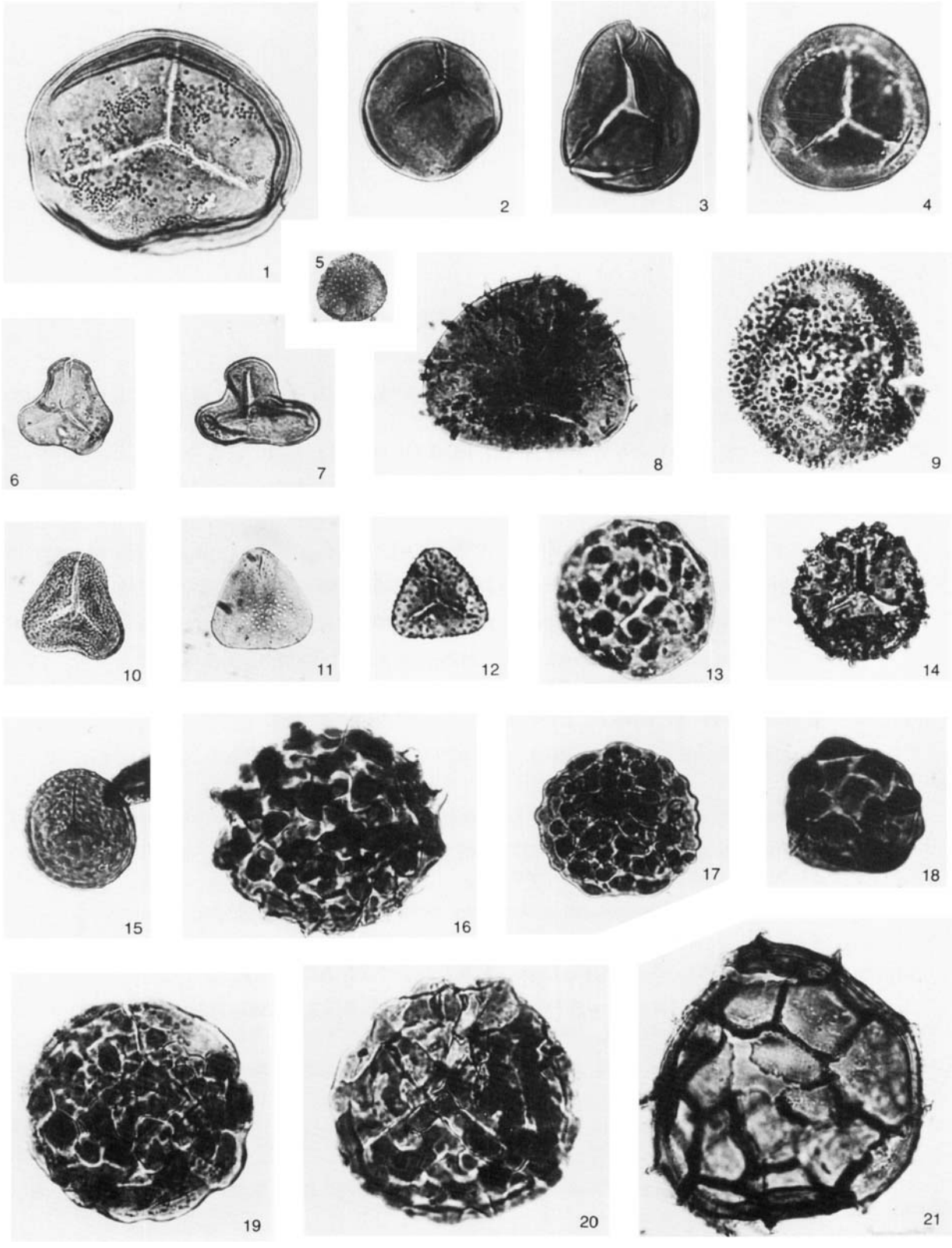
Plate 33



Explanation of Plate 34

All figures are × 500

Figs. 1, 2. *Diatomozonotriletes fragilis* Clayton *in* Neves *et al.*, 1973. Fig. 1. A1A–84, 5410ft., Slide 1, W40/2, AGC 810, 2. A1A–84, 5410ft., Slide 1, N32/0, AGC 811.

Fig. 3. *Diatomozonotriles* sp. A. A1–37, 7960ft., Core 12. S.G. 7960/13, AGC 812.

Fig. 4. *Rotaspora knoxi* Butterworth & Williams, 1958. J1–81A, 10020–10070ft., Slide 17005, V51/1, AGC 813. (Viséan–Namurian).

Fig. 5. *Cyrtospora cristifera* (Luber) Van Der Zwan, 1979. B1–2, 12510–12610ft., Slide 1, Q36/4, AGC 814.

Fig. 6. *Densosporites spitsbergensis* Playford, 1963. A1A–84, 5340ft., Slide 1, Q62/4, AGC 815.

Fig. 7. *Densosporites* cf. *spinifer* Hoffmeister, Staplin & Malloy, 1955. A1–37, 8162ft., Slide 1, J35/0, AGC 816.

Figs. 8, 14. *Densosporites variomarginatus* Playford, 1963. Fig. 8, A1–37, 8421ft., S.G. 8421/13, AGC 817. Fig. 14, A1A–84, 5520ft., Slide 1, Q48/3, AGC 818.

Fig. 9. *Densosporites* sp. A. A1–37, 8162ft., Core 13, S.G. 8162/9, AGC 819.

Fig. 10. *Lycospora pusilla* (Ibrahim) Somers, 1972. A1–NC92, 9500–9600ft., Slide 1, N39/3, AGC 820. (Viséan–Permian).

Fig. 11. *Prolycospora rugulosa* (Butterworth & Spinner) Turnau, 1978. A1–14, 8790–8900ft., Slide 1, Y52/4, AGC 821.

Figs. 12 & 13. *Cristatisporites* sp. A. Fig. 12. A1–37, 8162ft., Core 13, S.G. 8162/16, AGC 822. Fig. 13. A1–37, 8162ft., Core 13, S.G. 8162/1, AGC 823.

Fig. 15. *Densosporites intermedius* Butterworth & Williams, 1958. A1–37, 8131–8132ft., Core 13, S.G. 8131–8132/46, AGC 824.

Fig. 16. *Cristatisporites* sp. B. A1–37, 8162ft., Core 13, S.G. 8162/22, AGC 825.

Figs. 17, 22. *Spelaeotriletes triangulus* Neves & Owens, 1966. Fig. 17. B1–2, 12200–12300ft., Slide 1, H47/1. AGC 826. Fig. 22. J1–81A. 10020–10070ft., Slide 1, N43, AGC 827. (Viséan–Namurian).

Fig. 18. *Spelaeotriletes owensi* Loboziak & Alpern, 1978. A1A–84, 5180ft., Slide 1, V25/0, AGC 828. (Early Carboniferous).

Figs.19, 20. *Spelaeotriletes balteatus* (Playford) Higgs, 1976. *sensu* Massa *et al.*, 1980. Fig. 19, A1–37, 8145ft., Core 13, Slide 1, P41/0, AGC 829. Fig. 20, B1–2, 12200–12300ft., Slide 1, Y27/2, AGC 830. (Early Carboniferous).

Fig. 21. *Spelaeotriletes arenaceus* Neves & Owens, 1966. A1A–84, 5680ft., Slide 1, R44/0, AGC 831. (Tournaisian–Westphalian).

Fig. 23. *Spelaeotriletes pretiosus* (Playford) Neves & Belt, 1970. A1–37, 8162ft., Core 13, S.G. 8162/7, AGC 832.

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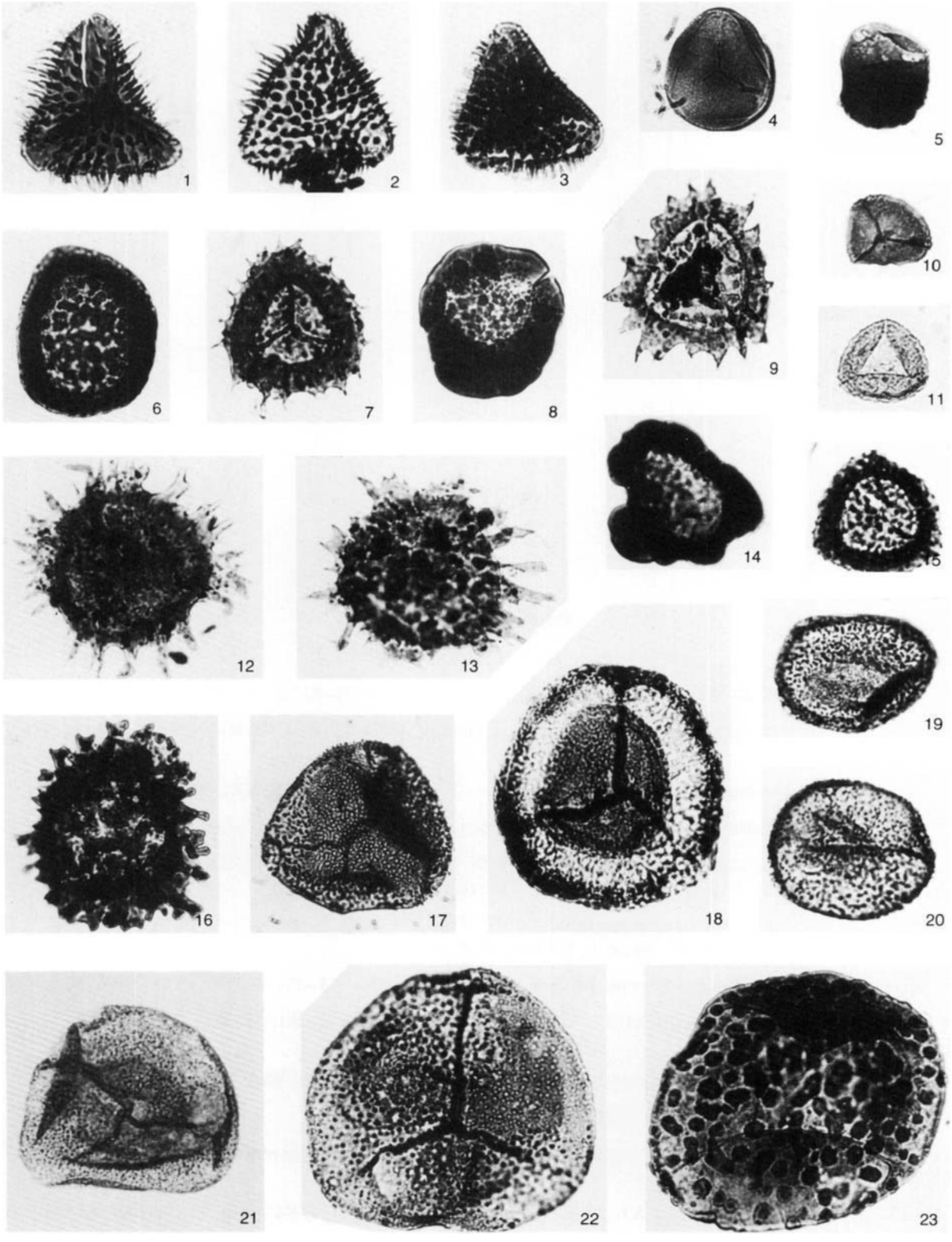
Plate 34



Explanation of Plate 35

All figures are × 500

Fig. 1. *Spelaeotriletes* sp. A. A1–37, 8131–8132ft., Core 13, S.G. 8131–8132/65, AGC 833.

Fig. 2. *Cirratriradites rarus* (Ibrahim) Schopf, Wilson & Bentall, 1944. J1–81A, 9440–9470ft., Slide 1, N46/2, AGC 834.

Fig. 3. *Spinozonotriletes uncatus* Hacquebard, 1957. A1–37, 8162ft., Core 13, S.G. 8162/10, AGC 835.

Fig. 4. *Radiizonates genuinus* (Jushko) Loboziak & Alpern, 1978. B1–2, 12200–12300ft., Slide 1, M34/2, AGC 836.

Figs. 5, 6. *Vallatisporites agadesi* Loboziak & Alpern, 1978. Fig. 5. A1A–84, 5180ft., Slide 1, U43/2, AGC 837. Fig. 6, A1–37. 8150ft., Core 3, S.G. 8150/10, AGC 838. (Early Carboniferous).

Figs. 7, 11. *Vallatisporites verrucosus* Hacquebard, 1957. Fig. 7, A1–37. 8162ft., Core 13, S.G. 8162/34, AGC 839. Fig. 11, B1–2, 12200–12300ft., Slide 1, U44/0, AGC 840.

Fig. 8. *Kraeuselisporites echinatus* Owens, Mishell & Marshall, 1976. A1–37, 8421ft., S.G. 8421/30, AGC 841.

Fig. 9. *Vallatisporites vallatus* Hacquebard, 1957. A1–37. 8162ft., Core 13, S.G. 8162/27, AGC 842. (Tournaisian–Early Viséan).

Fig. 10. *Vallatisporites* cf. *ciliaris* (Luber) Sullivan, 1964. A1A–84, 5180ft., Slide 1, Q24/0, AGC 843.

Fig. 12. *Perotrilites* sp. A. A1A–84, 5780ft., Slide 1, T47/0, AGC 844.

Fig. 13. *Colatisporites decorus* (Bharadwaj & Venkatachala) Williams *in* Neves *et al.*, 1973. A1A–84, 5410ft., Slide 1, U49/2, AGC 845.

Figs. 14, 15. Spore Type A. Fig. 14, A1–37, 8421ft., S.G. 8421/29, AGC 846. Fig. 15, A1–37, 8162ft., Core 13, S.G. 8162/11, AGC 847.

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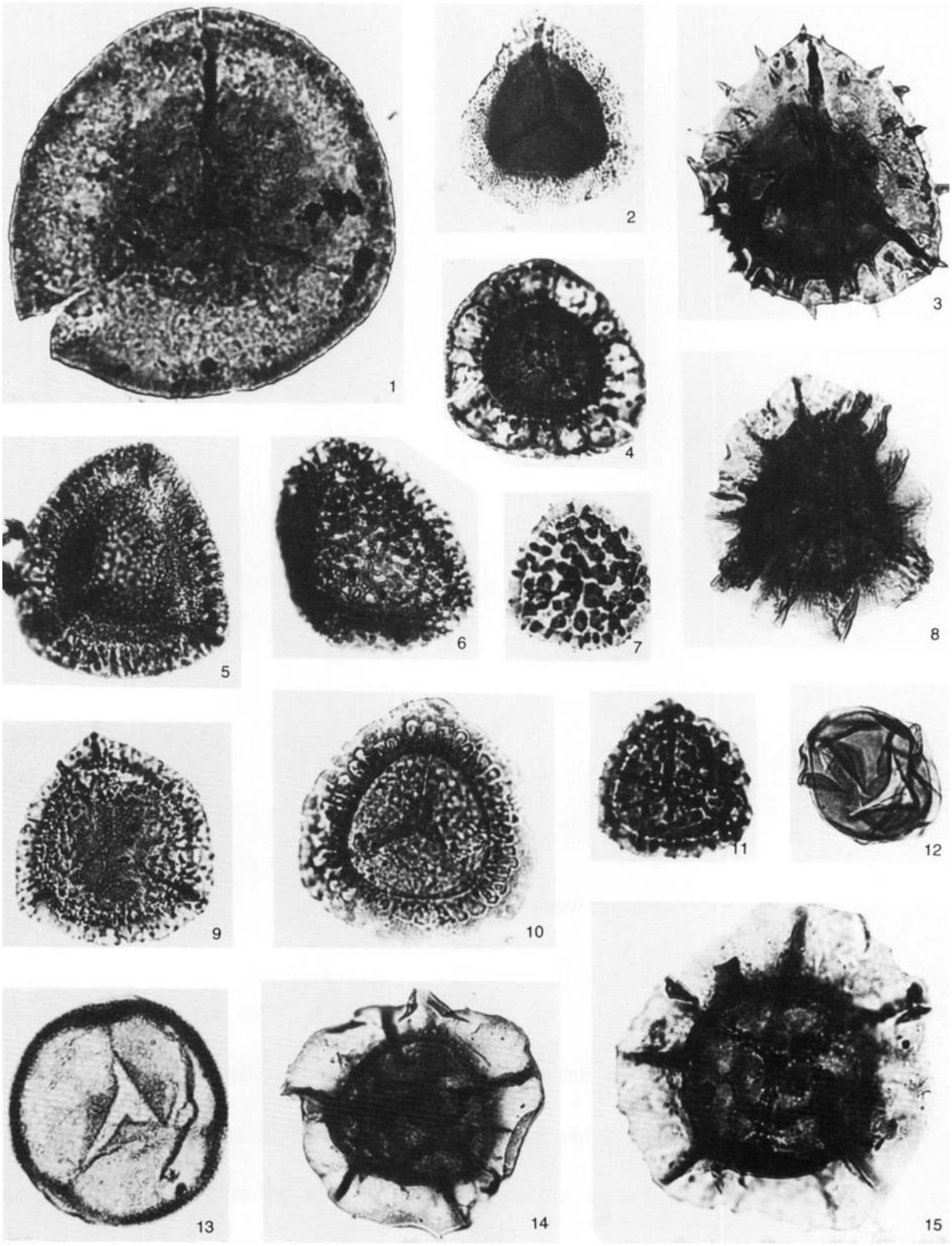
Plate 35



Explanation of Plate 36

All figures are × 500

Fig. 1. *Potonieisporites* sp. A1–14. 8030–8100ft., Slide 872 (4), S46/2, AGC 783.

Fig. 2. *Rimospora rimosa* Lele & Maithy, 1969. A1–14, 7910–8000ft., Slide 871 (4), N40/4, AGC 784. (Serpukhovian–Permian).

Fig. 3. *Cannanoropollis janakii* Potonié & Sah, 1958. A1–14, 7910–8000ft., Slide 871 (4), C32/4, AGC 785. (Serpukhovian–Permian).

Fig. 4. *Cannanoropollis janakii* Potonié & Sah, 1958. A1–14, 7910–8000ft., Slide 871 (4), R48/3, AGC 786. (Serpukhovian–Permian).

Fig. 5. *Plicatipollenites malabarensis* (Potonié & Shah, 1958), Foster, 1975. A1–14, 7910–8000ft., Slide 871 (4), M36/2, AGC 787. (Serpukhovian–Permian).

Fig. 6. *Barakarites* sp. A1–14, 8110–8200ft., Slide 873 (4), G32/3, AGC 788.

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Carboniferous Miospores and Pollen

Plate 36