Paléobotanique
Paléopalynologie
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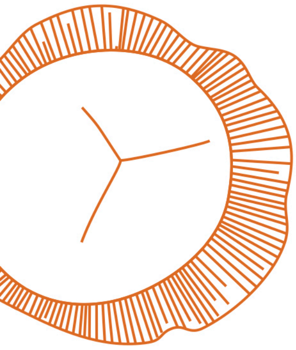

Devonian Miospore Palynology in Western Gondwana:

An application to oil exploration

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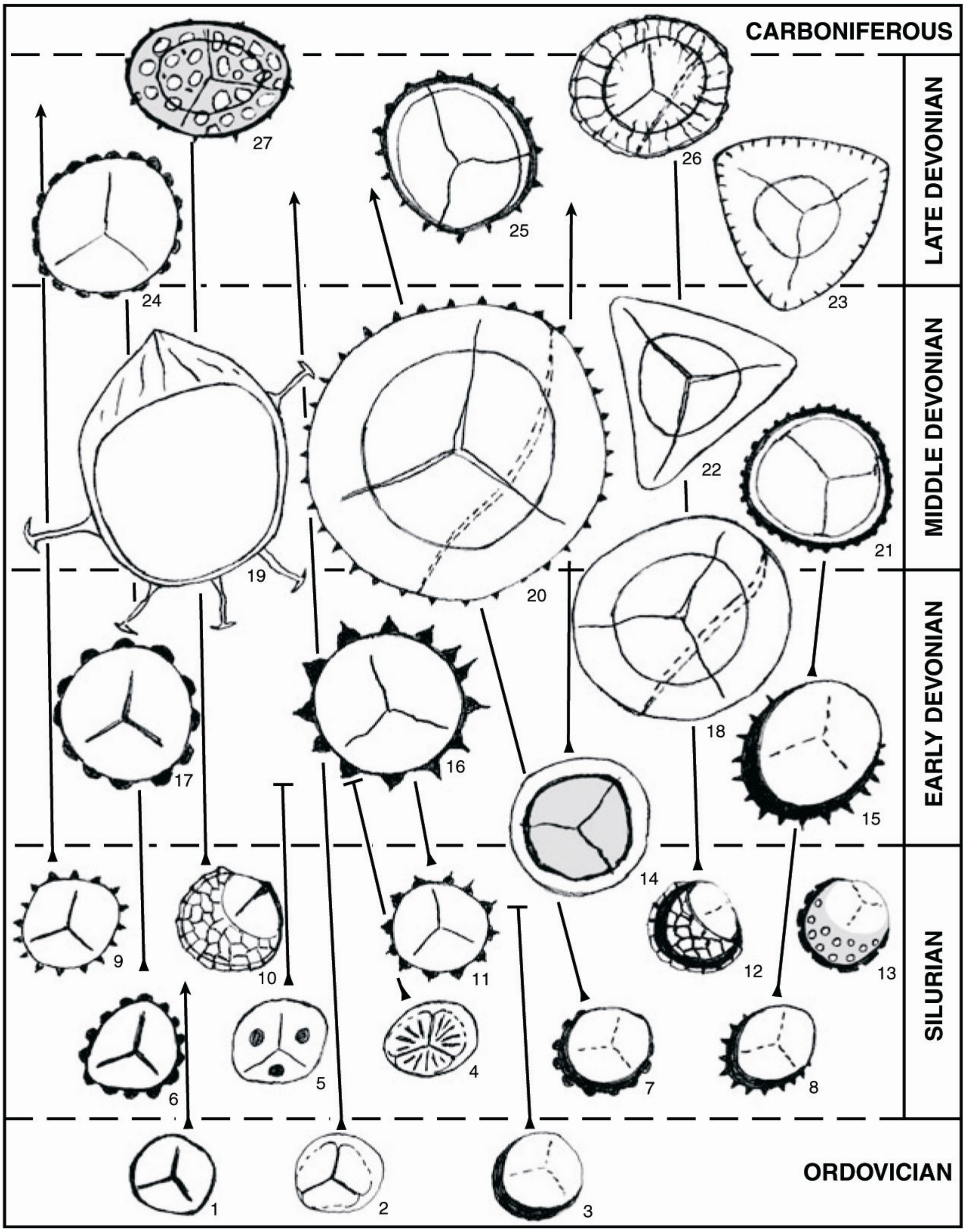

Fig. 1.3. Morphological trends of miospores from Ordovician to basal Carboniferous (Loboziak et al., 2005). 1: the first undoubted trilete mark at one pole; 2: haptotypic (linked to the tetrad status) proximo-subequatorial features (retusoid miospores); 3: distal thickening of the exine (patina);4: proximal radial muri; 5: interradial papillae; 6, 17 and 24: verrucate sculpture; 7: patinate verrucate sculpture; 8 and 15: patinate apiculate sculpture; 9: apiculate sculpture; 10: reticulate sculpture; 11 and 16: biform sculptural elements; 12: patinate reticulate sculpture; 13: patinate foveolate sculpture; 14: equatorial extension of an external layer of the exine, the sexine (acamerate); 18: two-layered zonate, camerate (cavity between the sexine and the inner layer, the nexine); 19: two-layered azonate with bifurcated spines; 20, 21 and 25: two-layered zonate, camerate, with apiculate sculpture; 22: two-layered zonate, acamerate; 23: two-layered zonate, camerate, endoreticulate; 26: three-layered zonate, camerate; 27: two-layered zonate, camerate, with apiculate, reticulate sculpture.

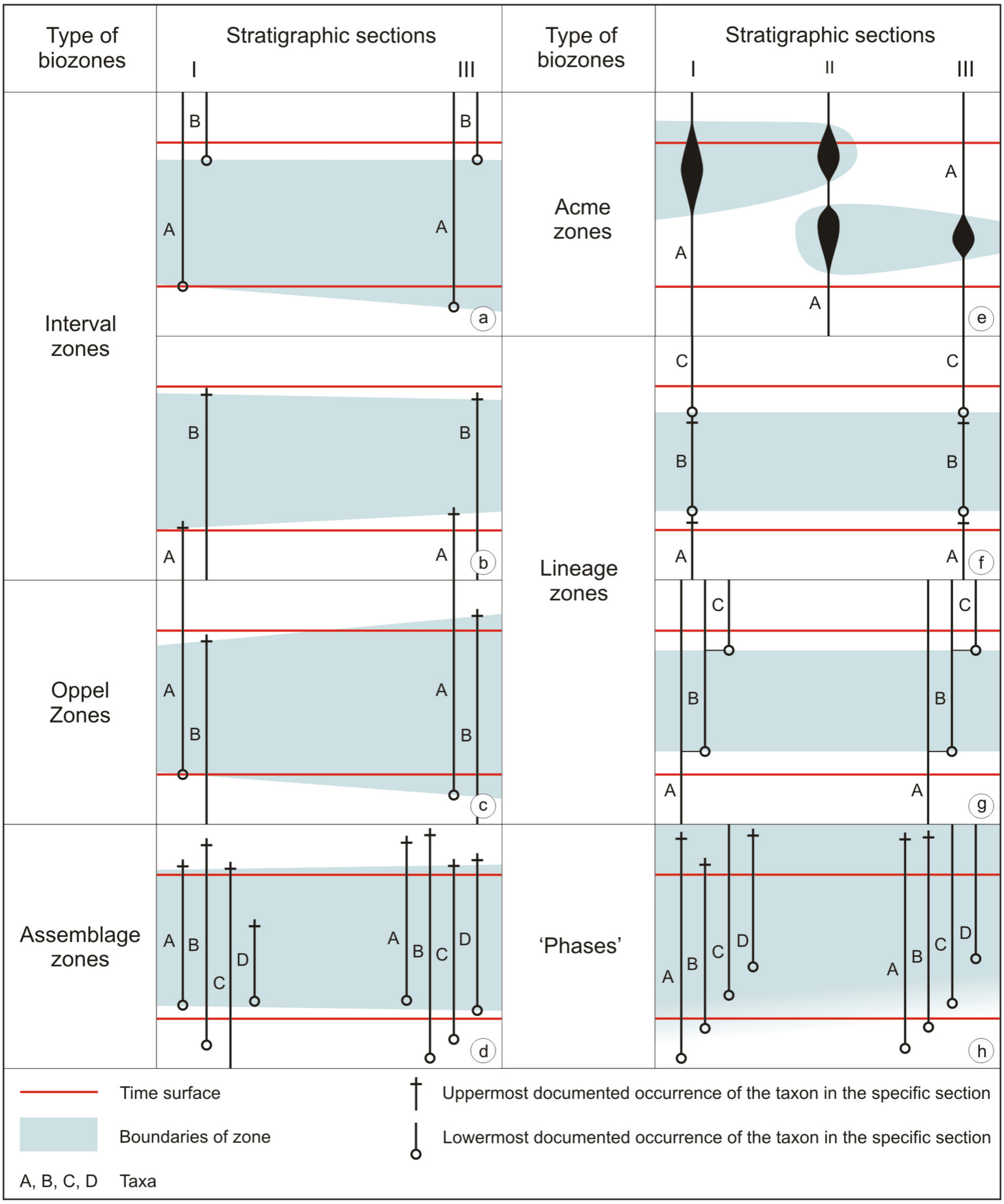

Fig. 1.4. Types of biozones mainly used in palynological studies (partly inspired from Salvador, 1994). a: the 'lowest-occurrence zone' represents the range between the lowest occurrence of taxa A and B; b: the 'highest-occurrence zone' represents the range between the highest occurrence of taxa A and B; c: the lowest boundary of the zone is the lowermost occurrence of taxon A and the upper boundary is the highest occurrence of taxon B; d: the assemblage diagnostic of the zone include four taxa with diverse stratigraphic ranges, the lower boundary is placed at the lowermost occurrence of index taxa A or D and the upper boundary at the highest occurrence of taxon C; e: the abundance zone represents the range of taxon A where it is the most abundant; f: the lineage zone represents the entire range of taxon B, from the highest occurrence of its ancestor, taxon B; g: the lineage zone represents the part of the range of taxon B between its lowest occurrence and the lowest occurrence of its descendant, taxon C; h: the lowermost boundary is fuzzy because the emphasis is on gradual development over time of the assemblage.

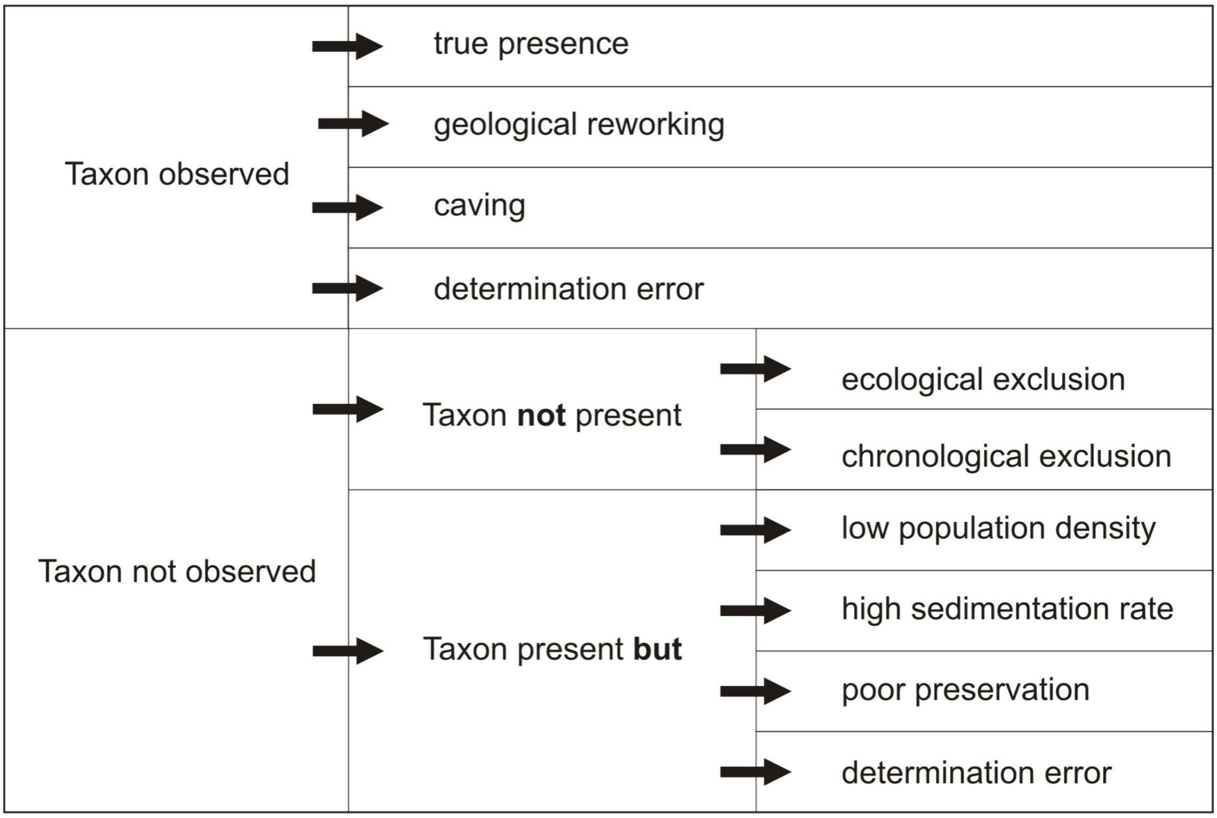

Fig. 1.5. Factors bearing on the quality of the fossil record (modified after Gradstein et al., 1985). The presence or absence of a taxon depend on multiple factors.

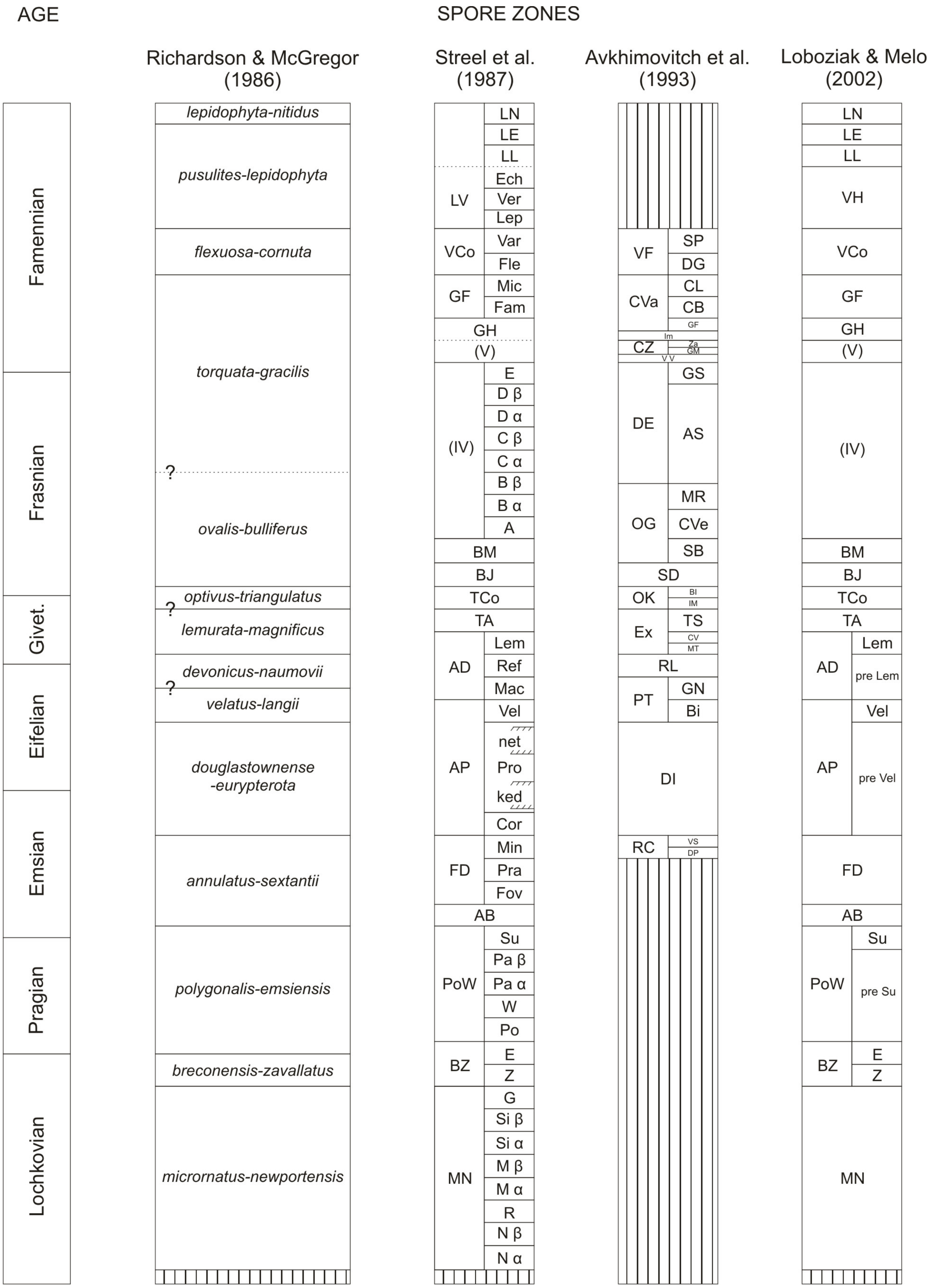

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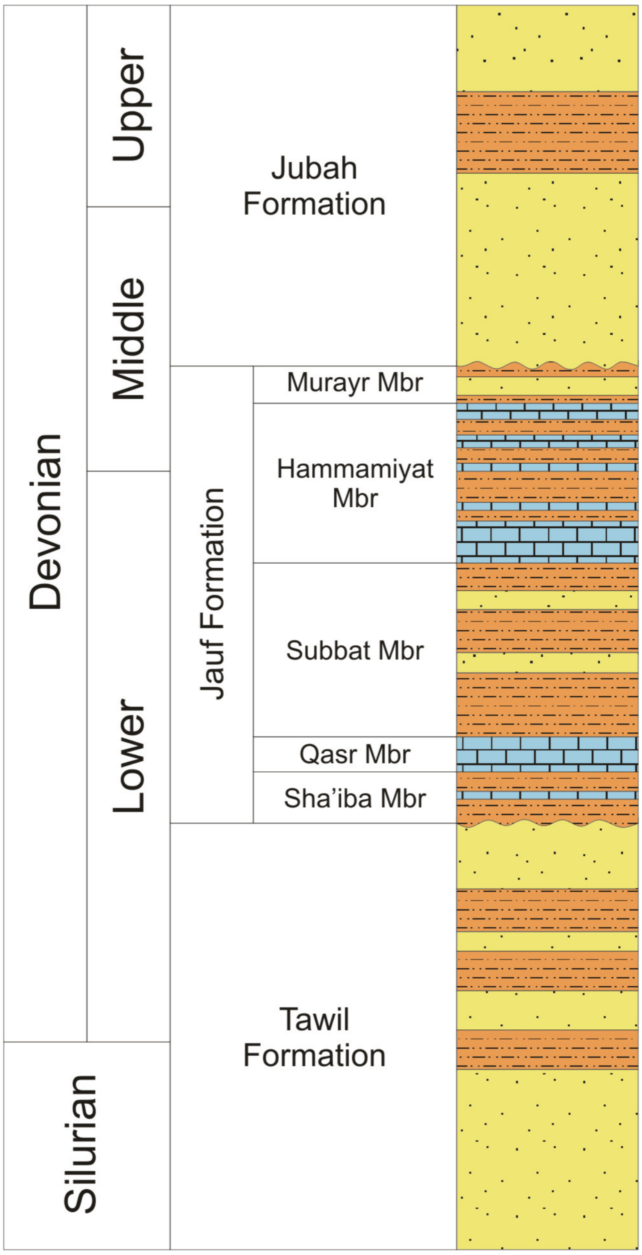
Fig. 2.1. Main sedimentary basins and regional tectonic structure of the Arabian Plate. Basement and Palaeozoic outcrops are shown by various colours.



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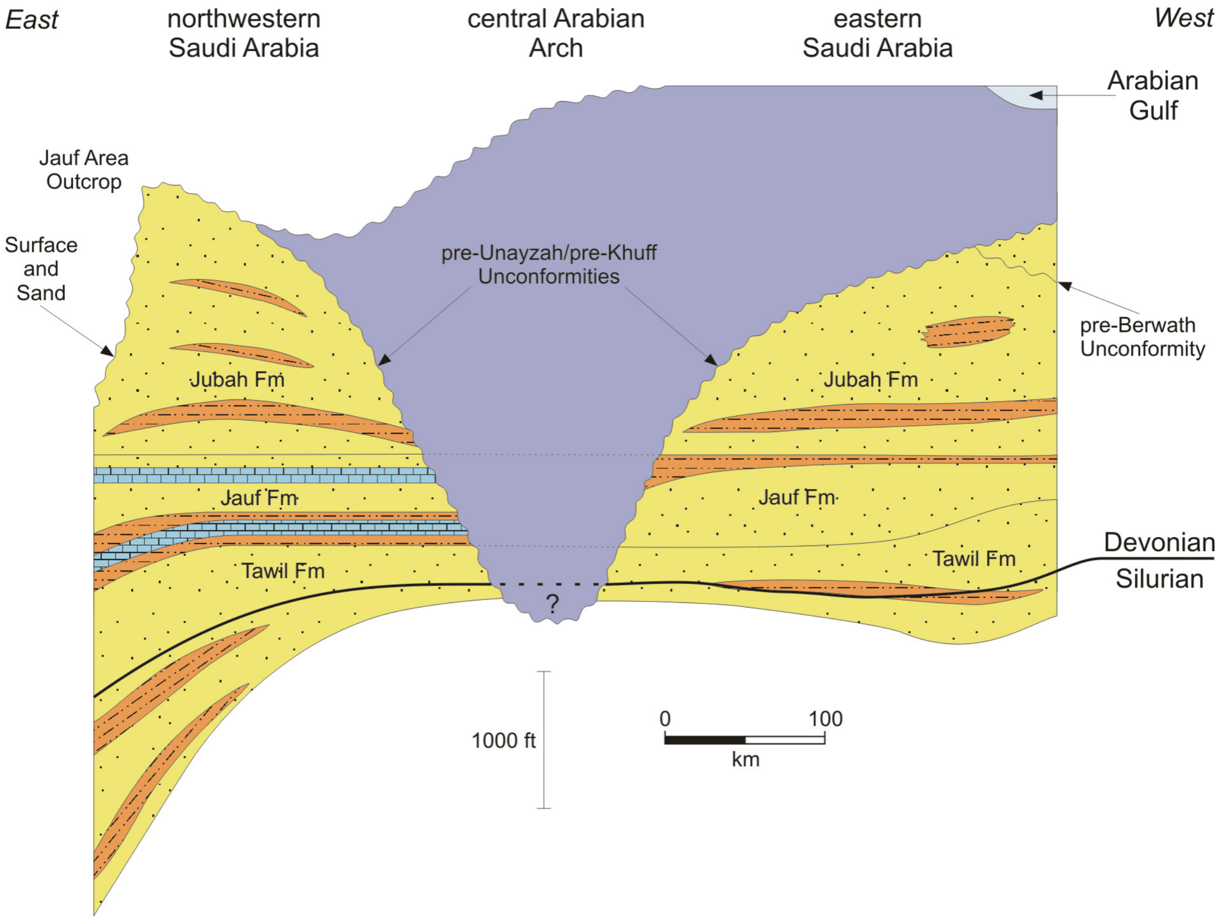

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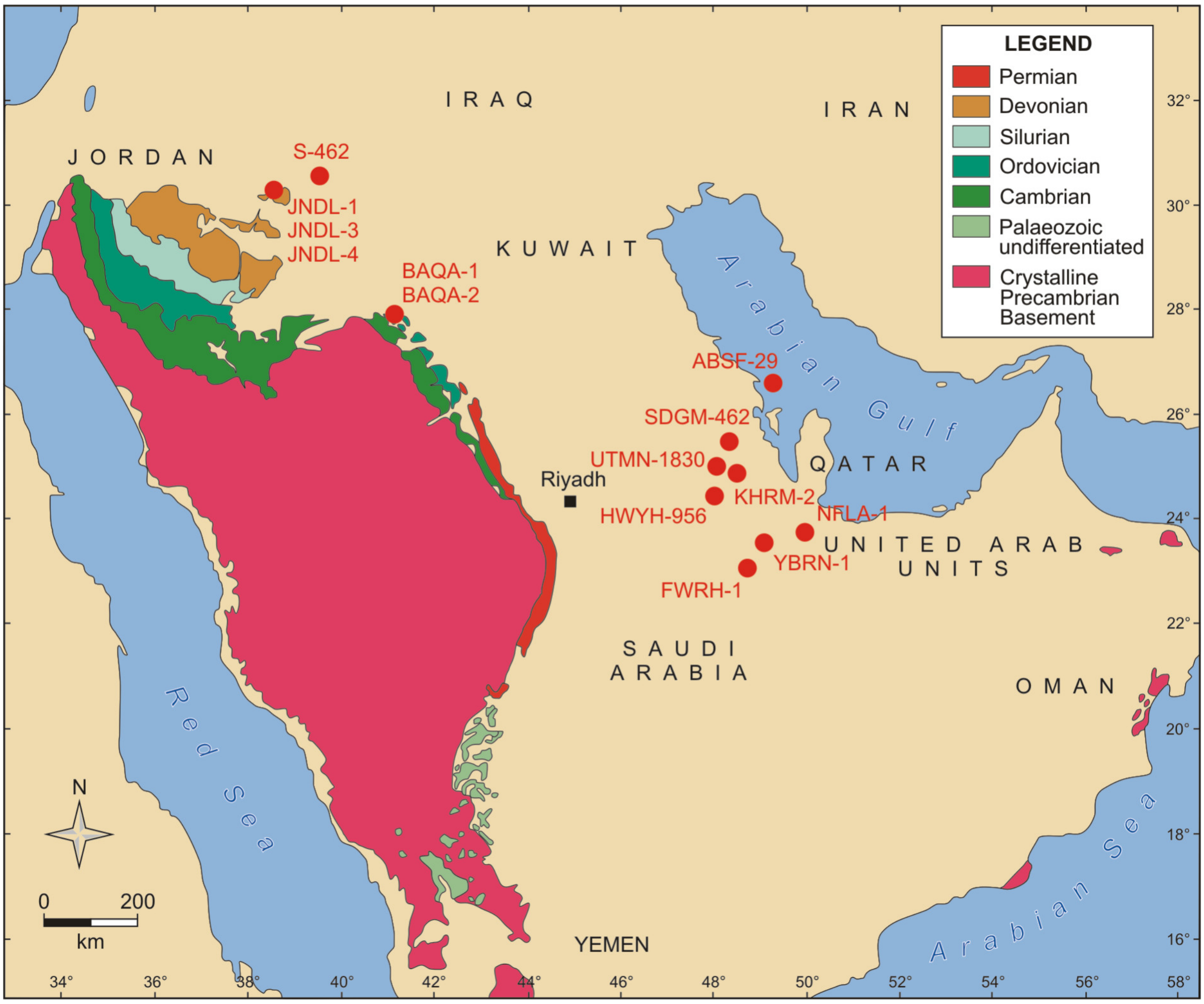
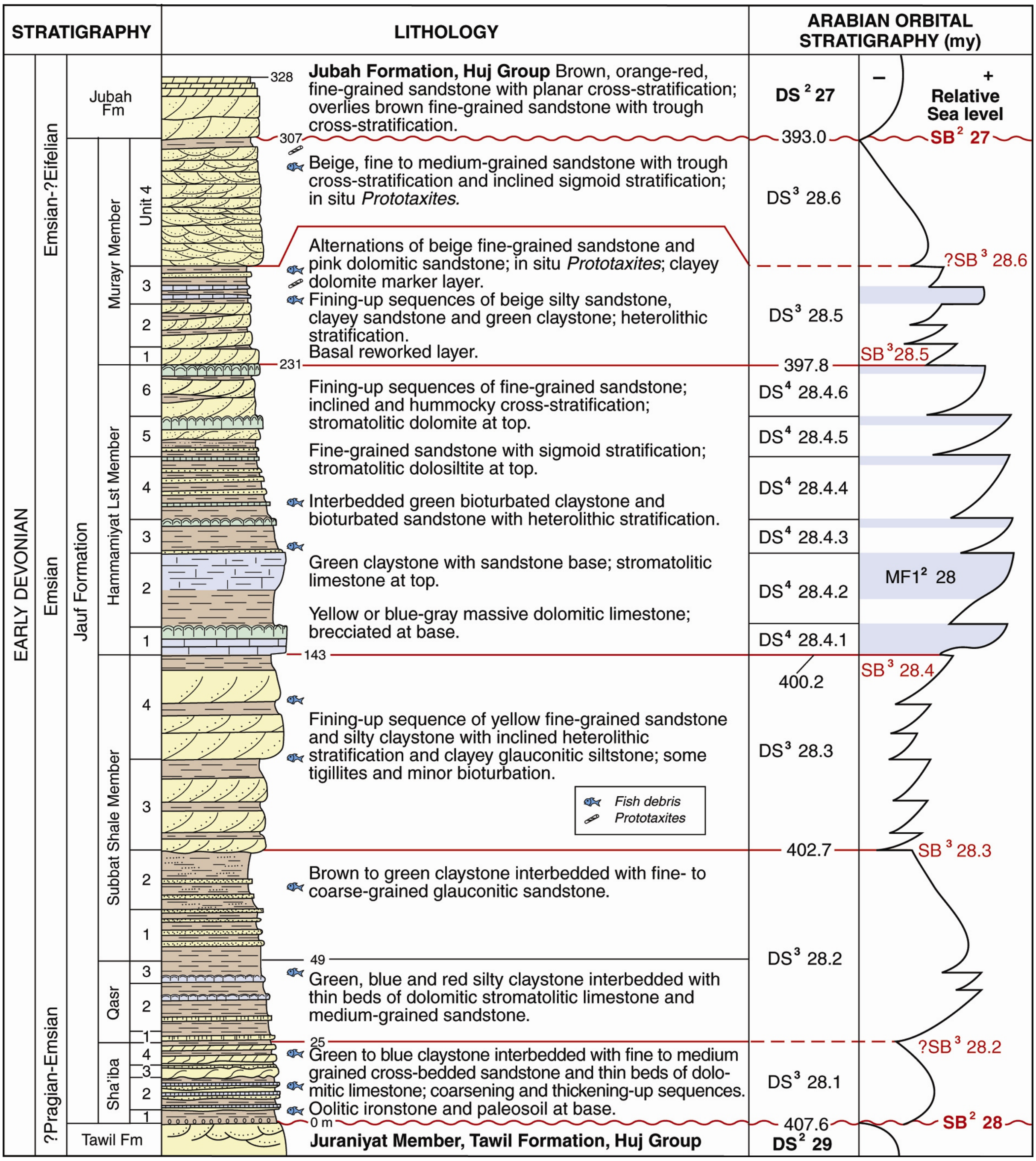


Fig. 2.4. Location of studied boreholes/wells on the Arabian Peninsula. Basement and Palaeozoic outcrops are shown by various colours.



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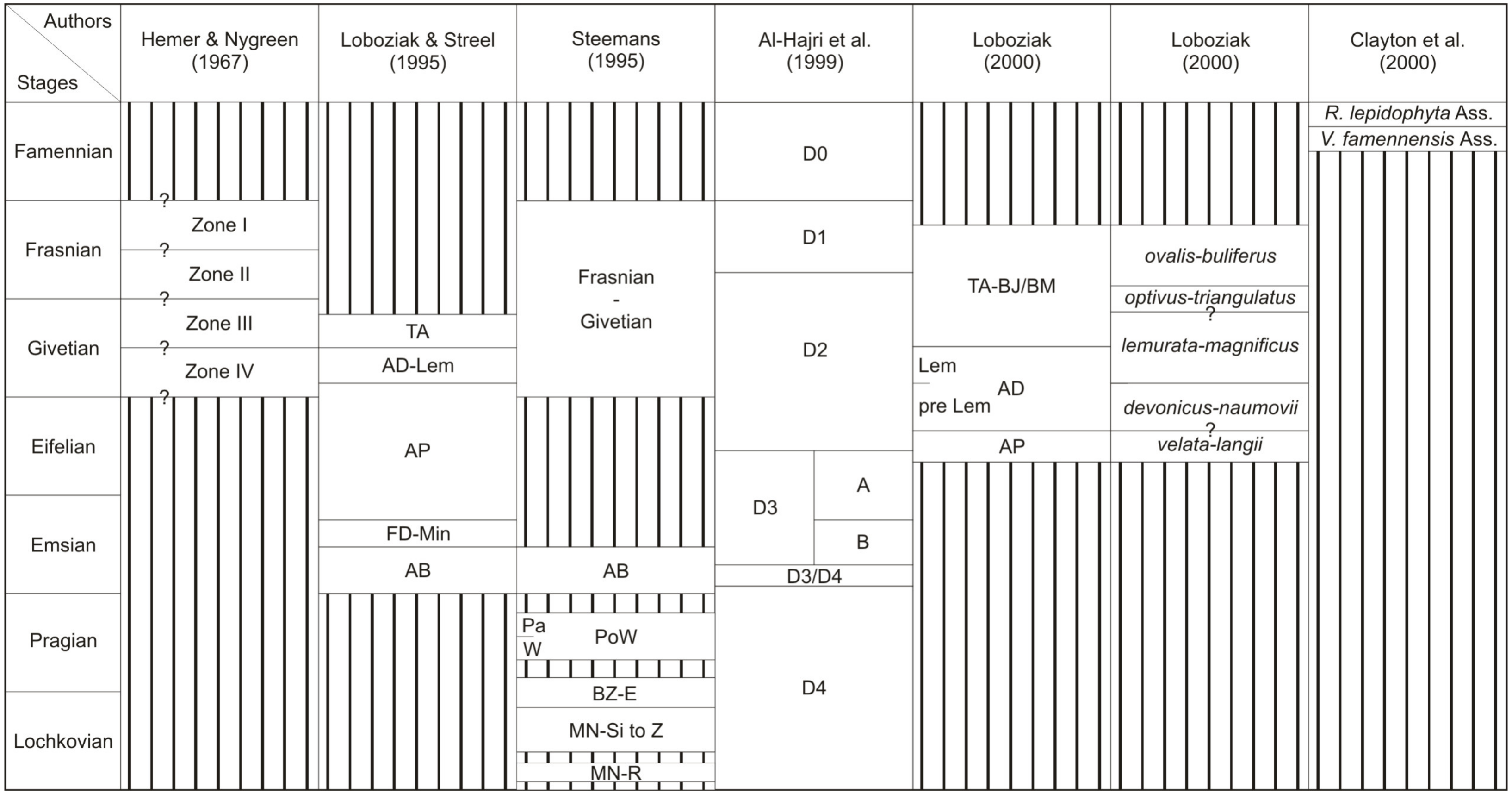

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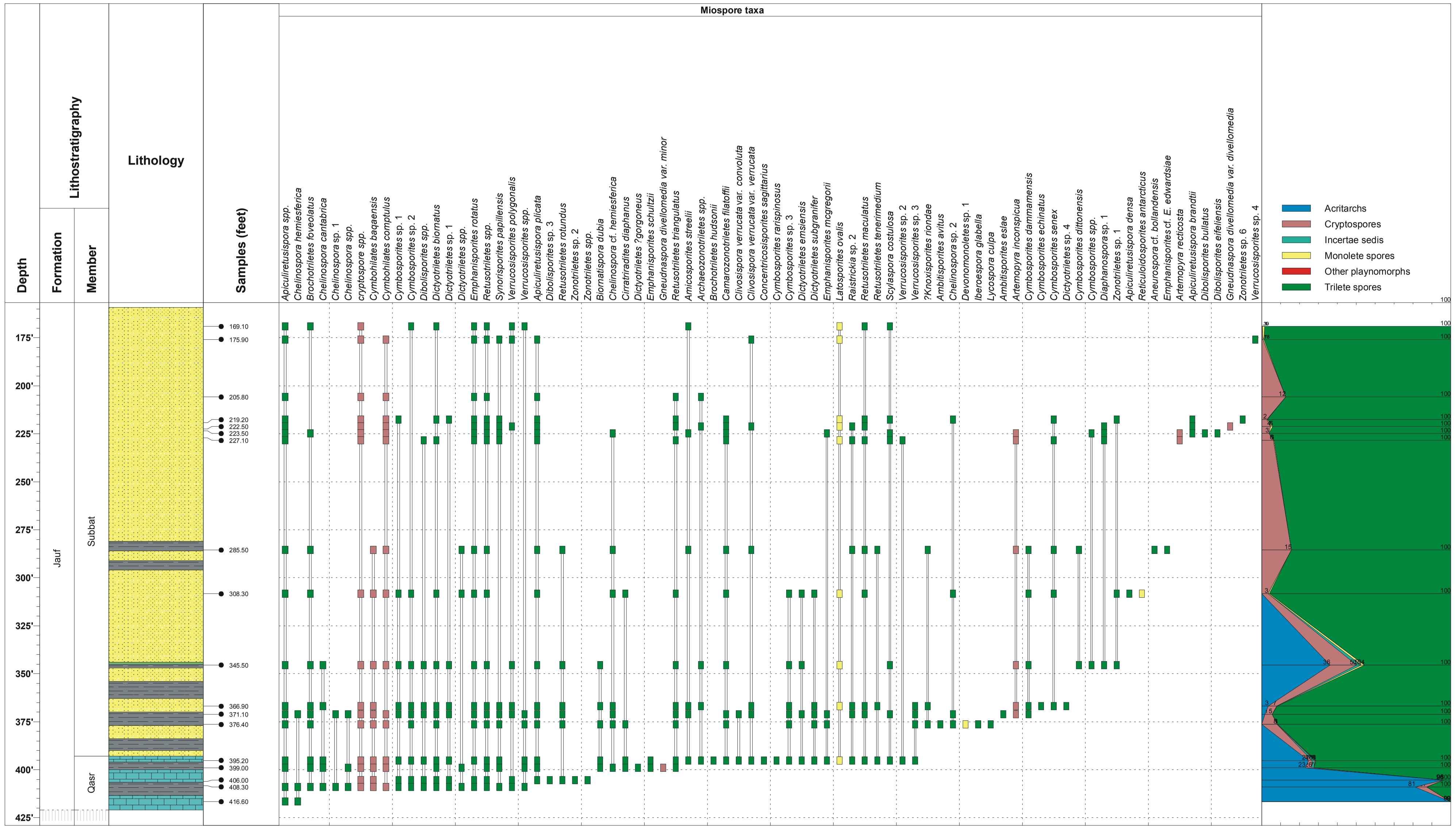
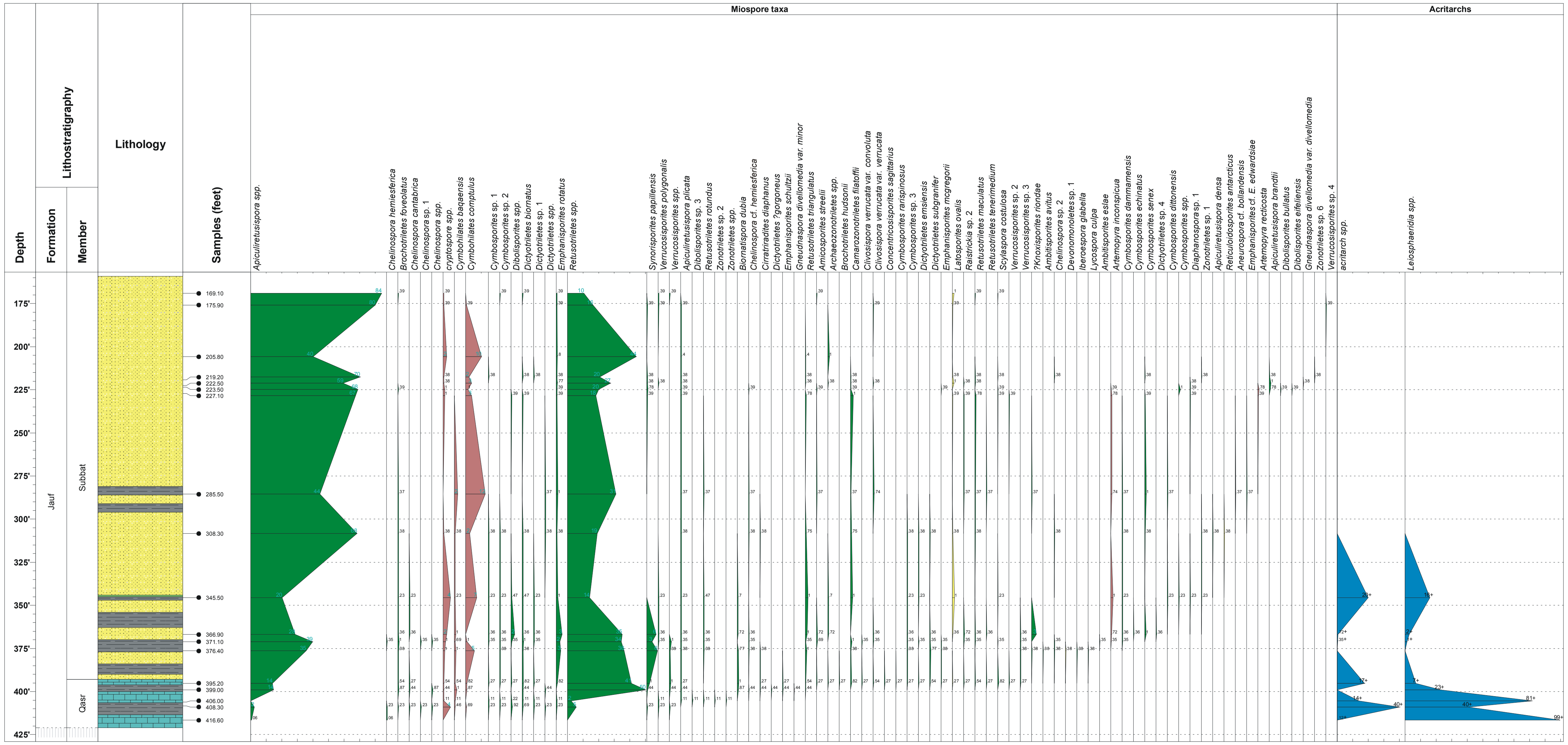


Fig. 2.7. Stratigraphic ranges of miospores encountered in borehole BAQA-1.



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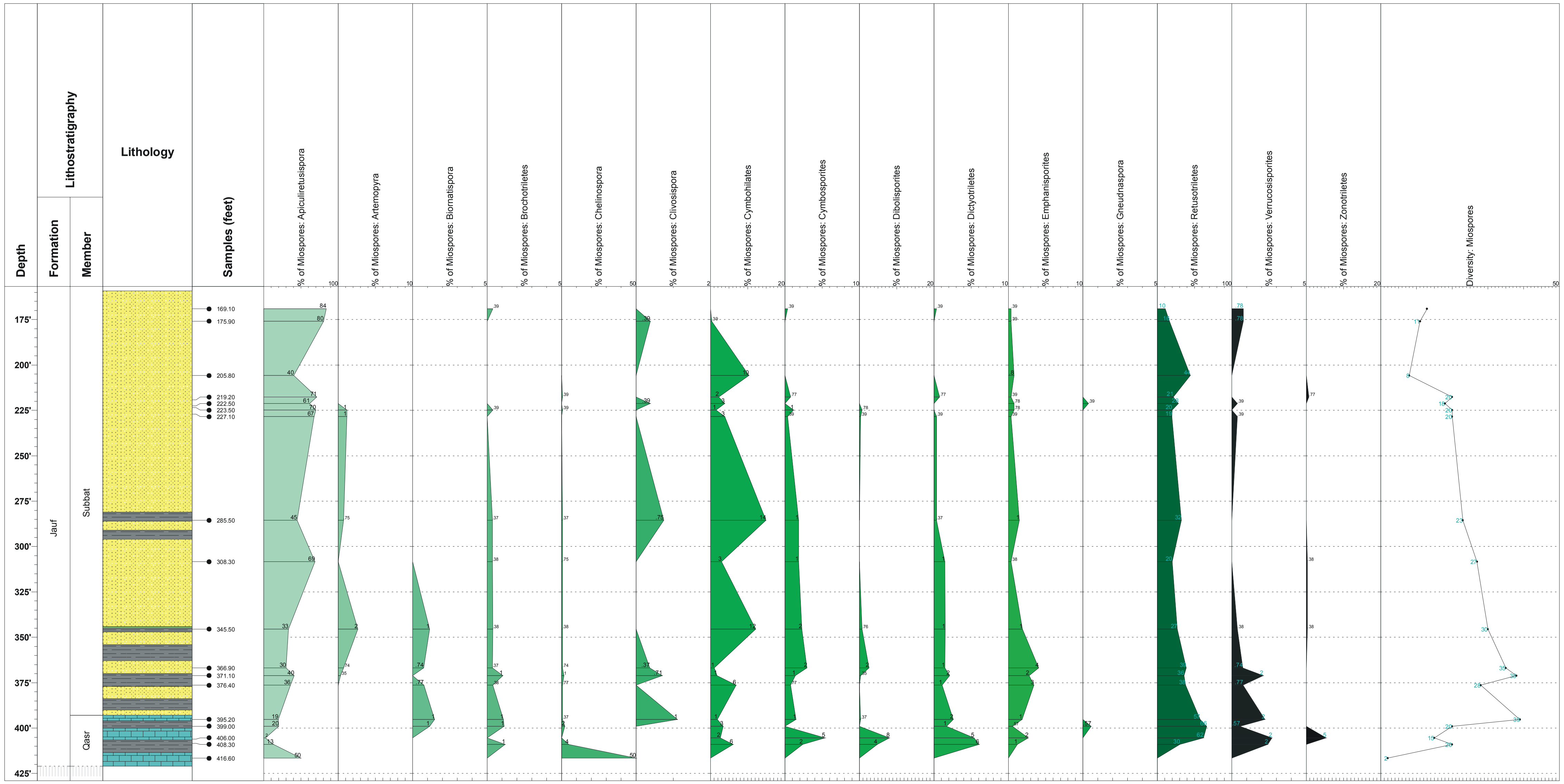

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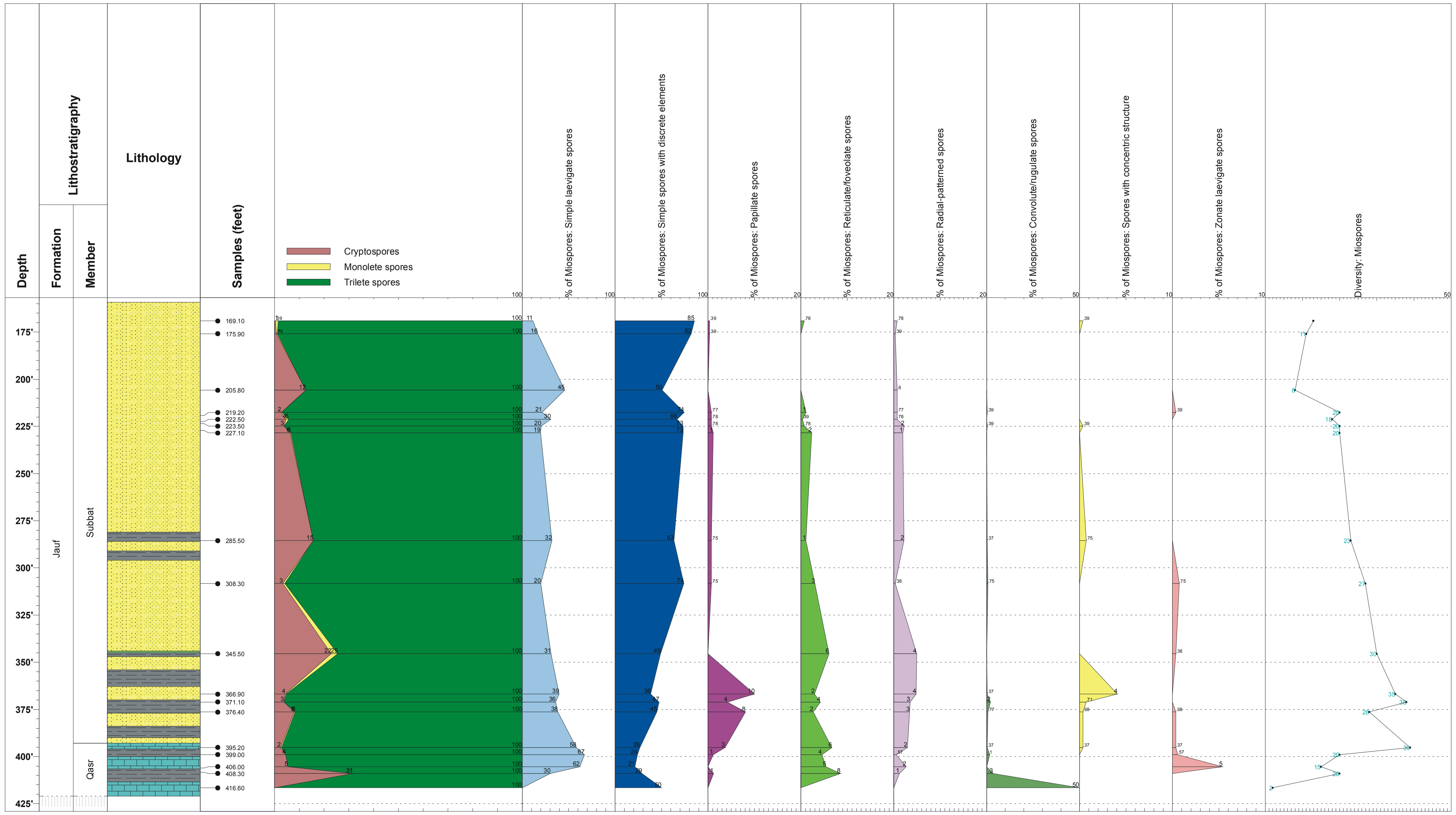

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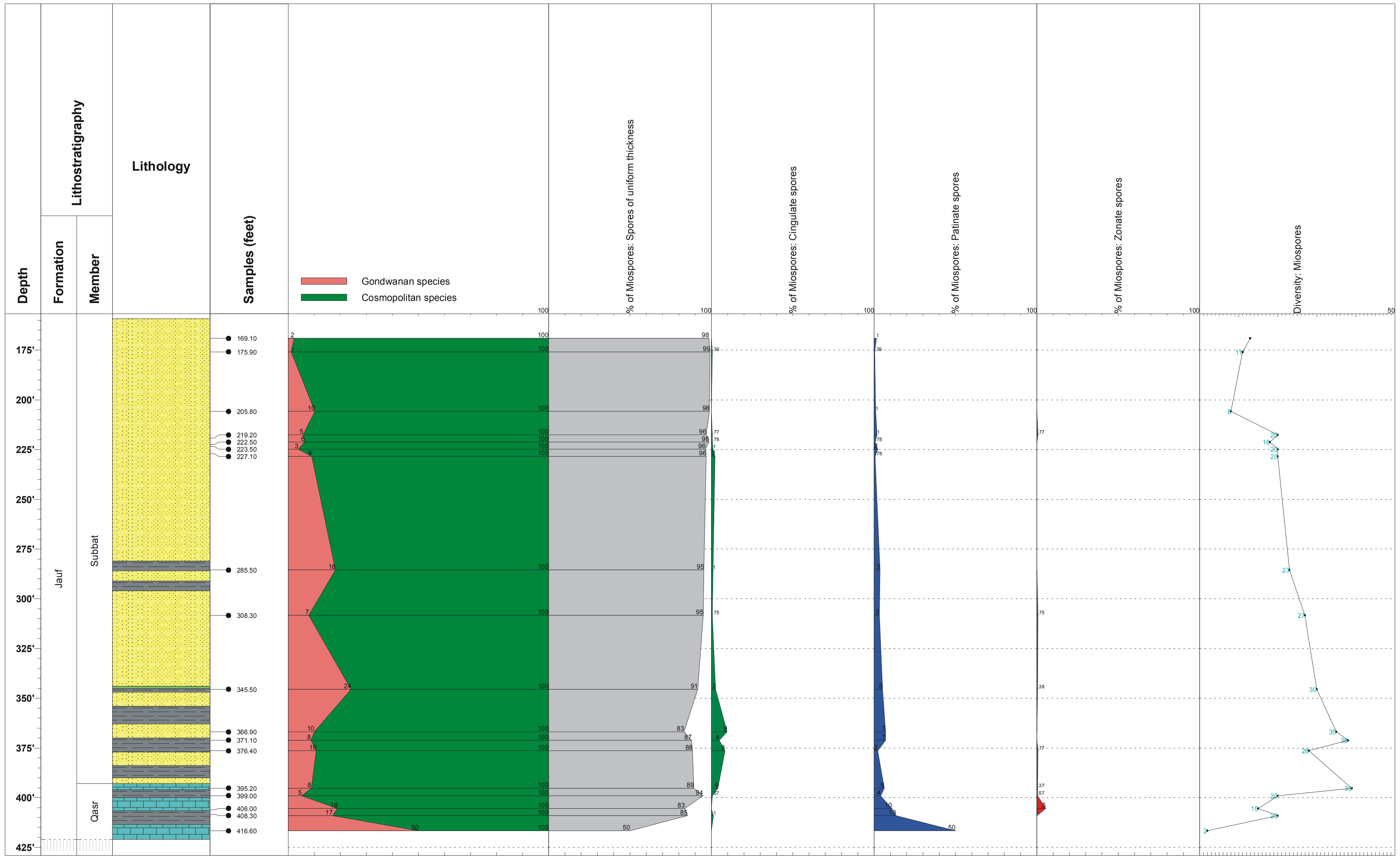

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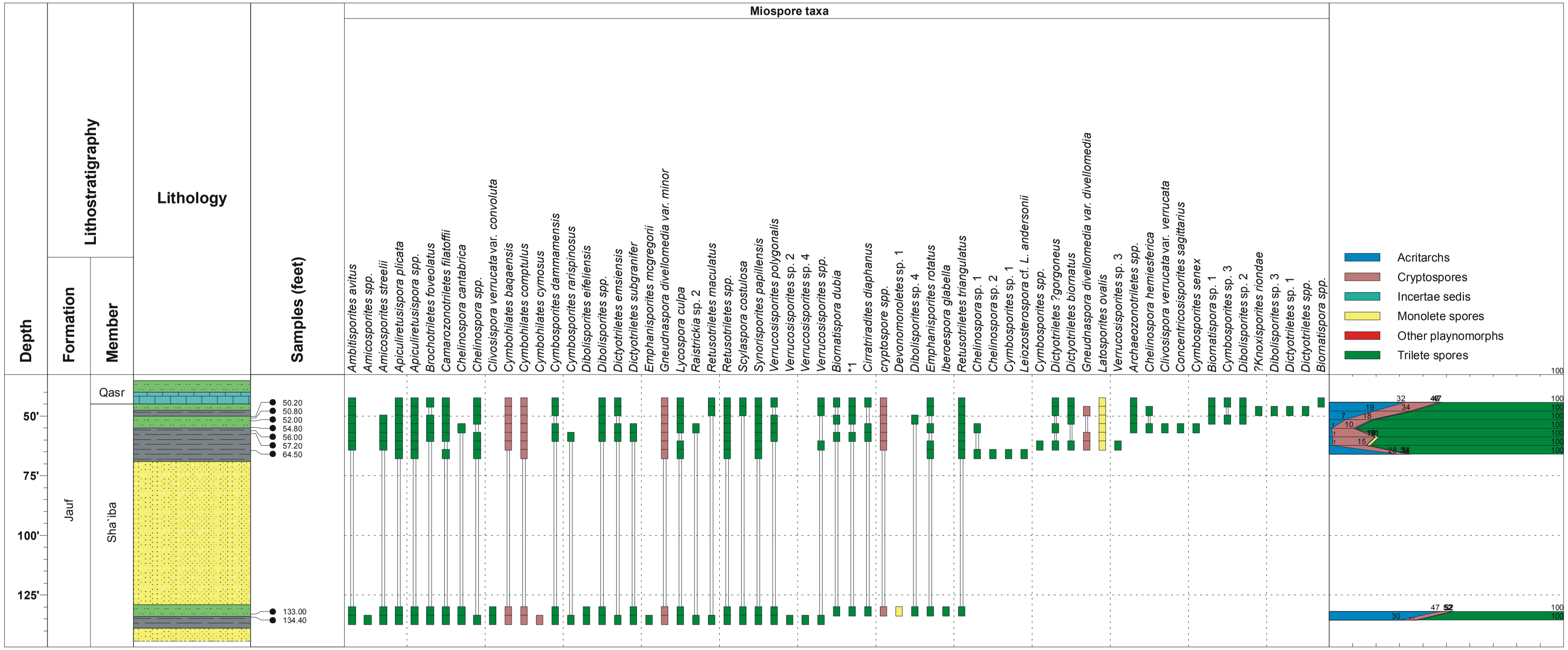

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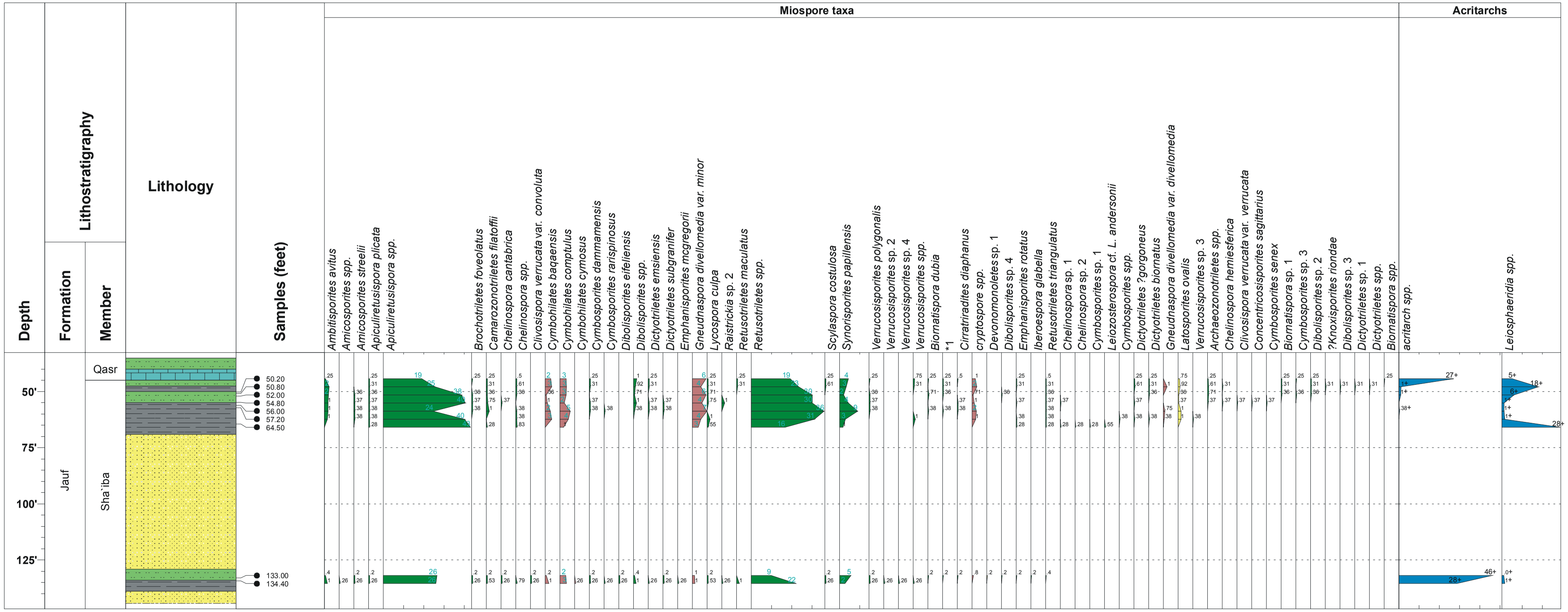

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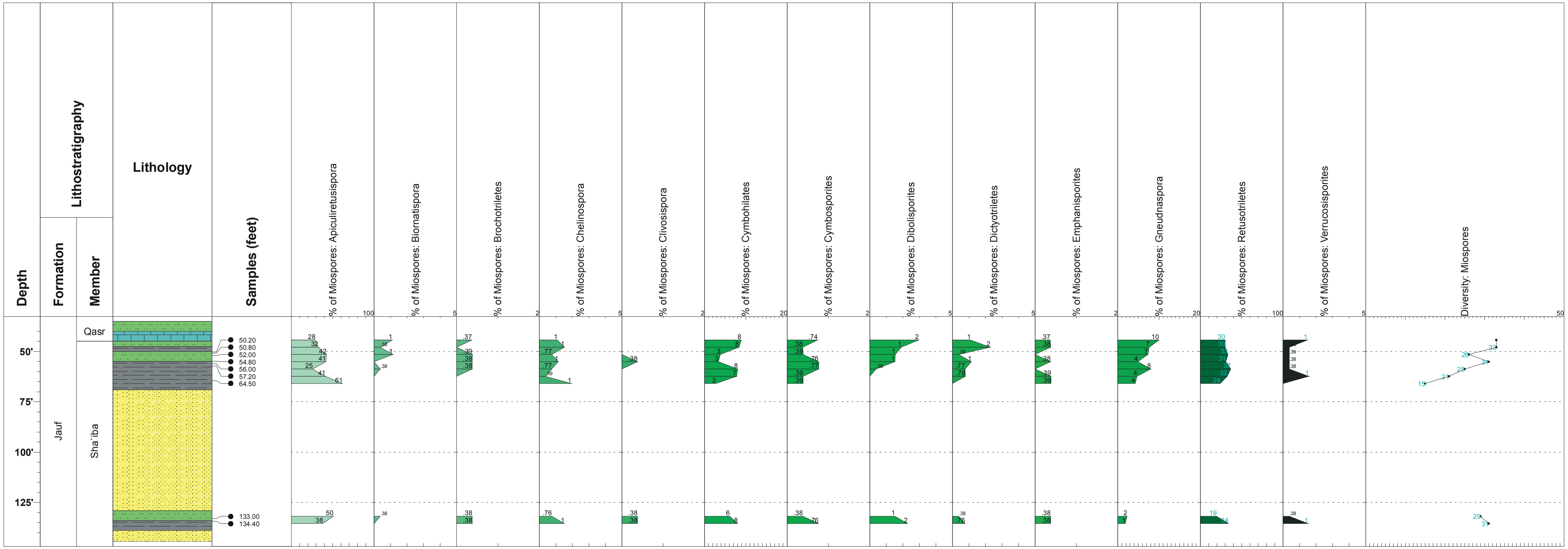

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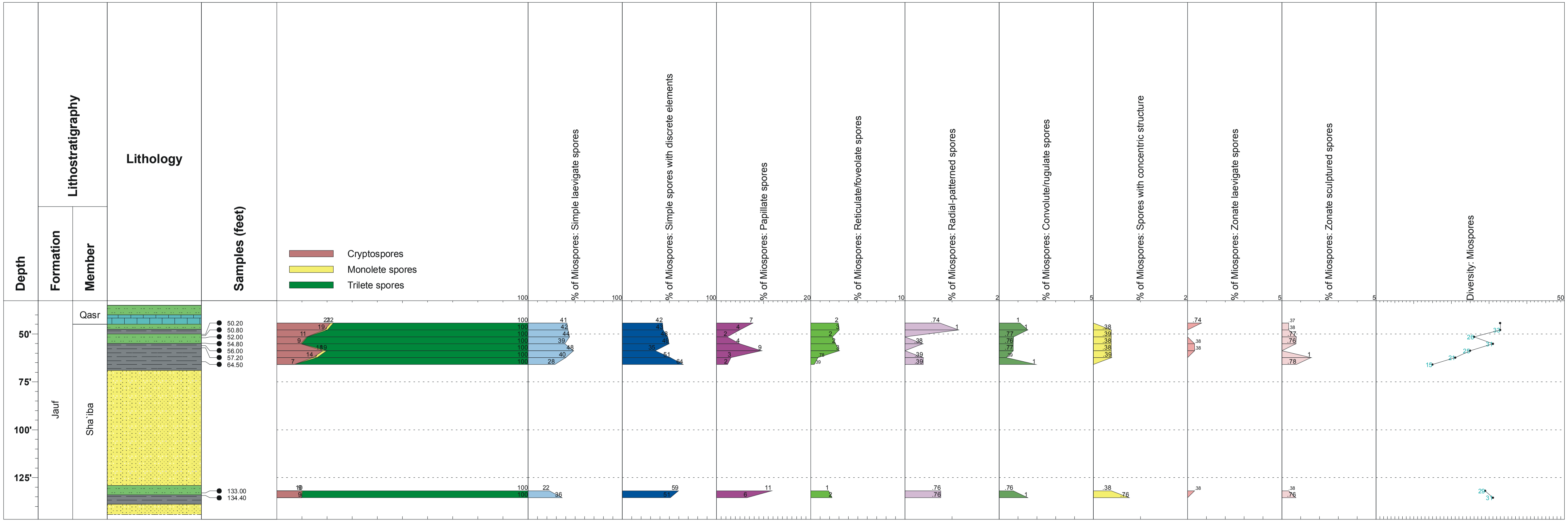

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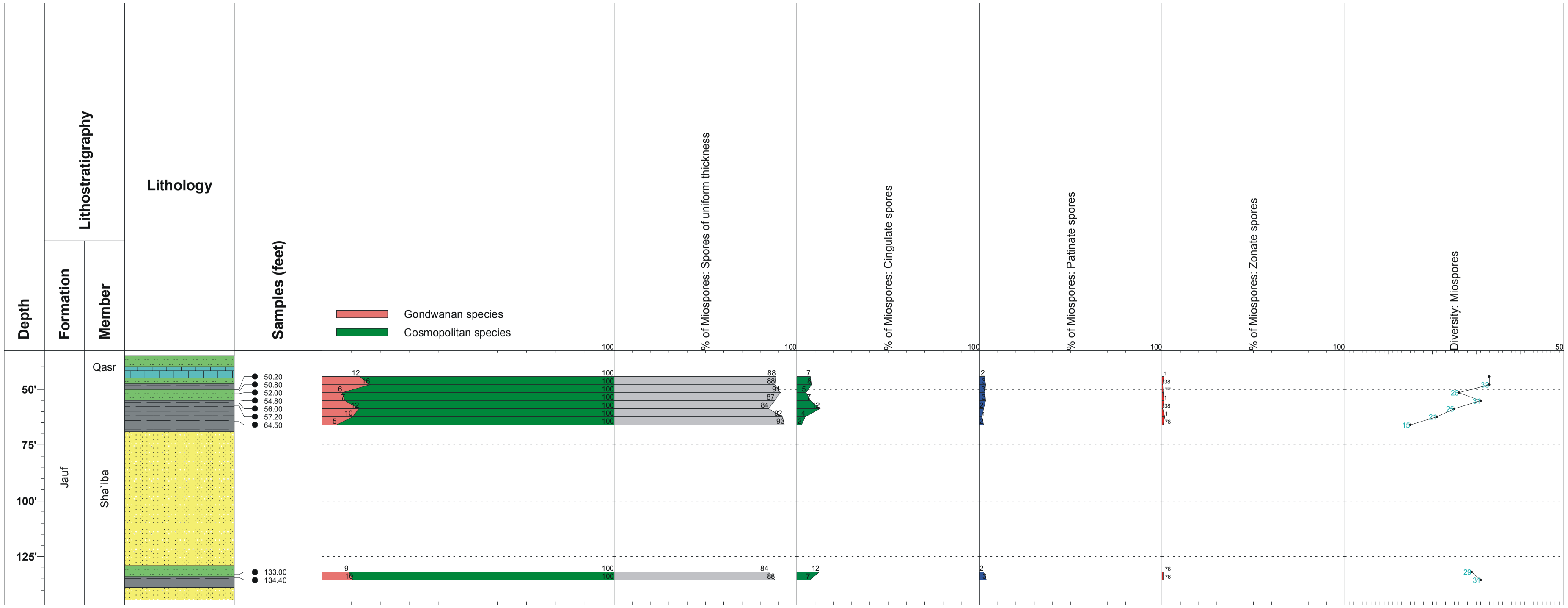

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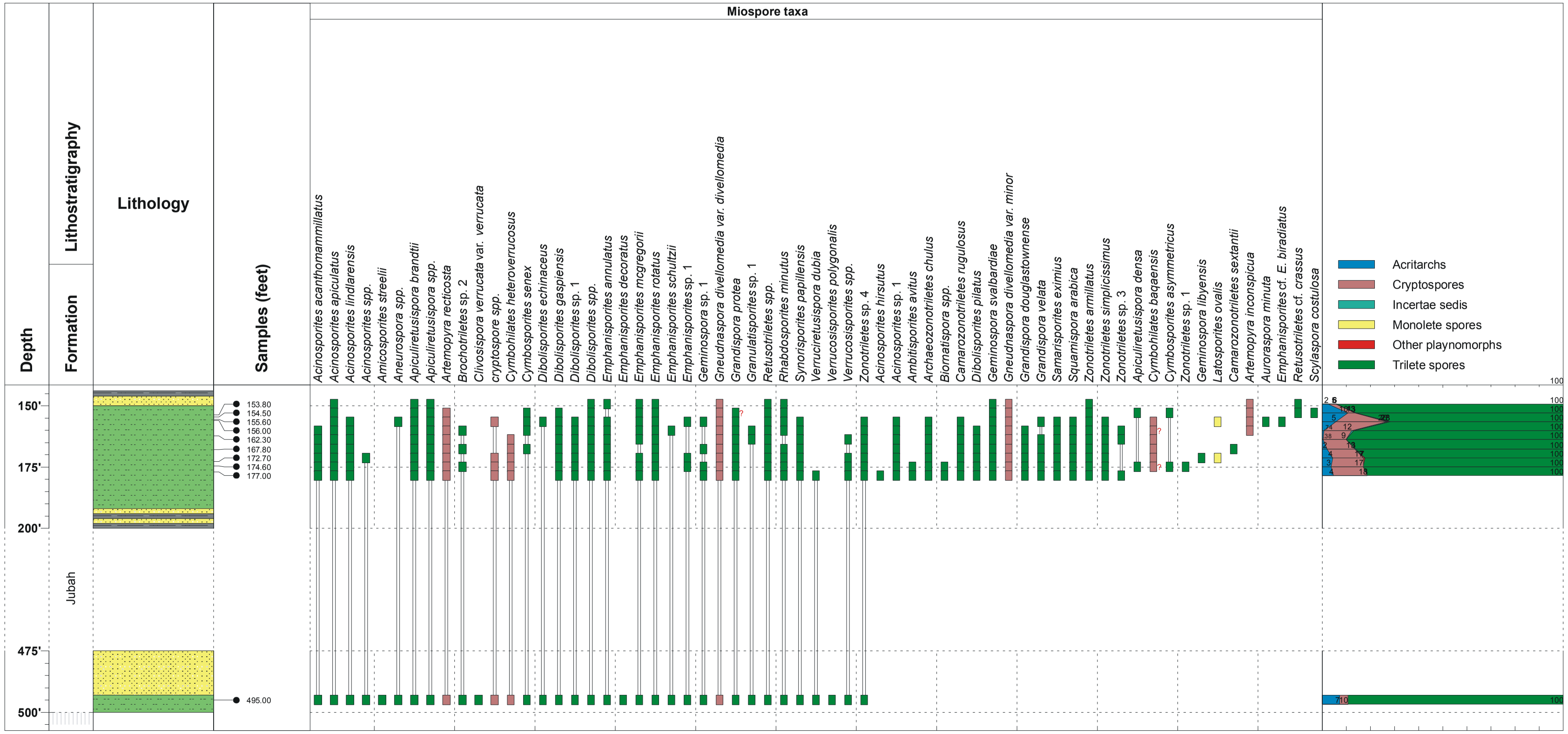

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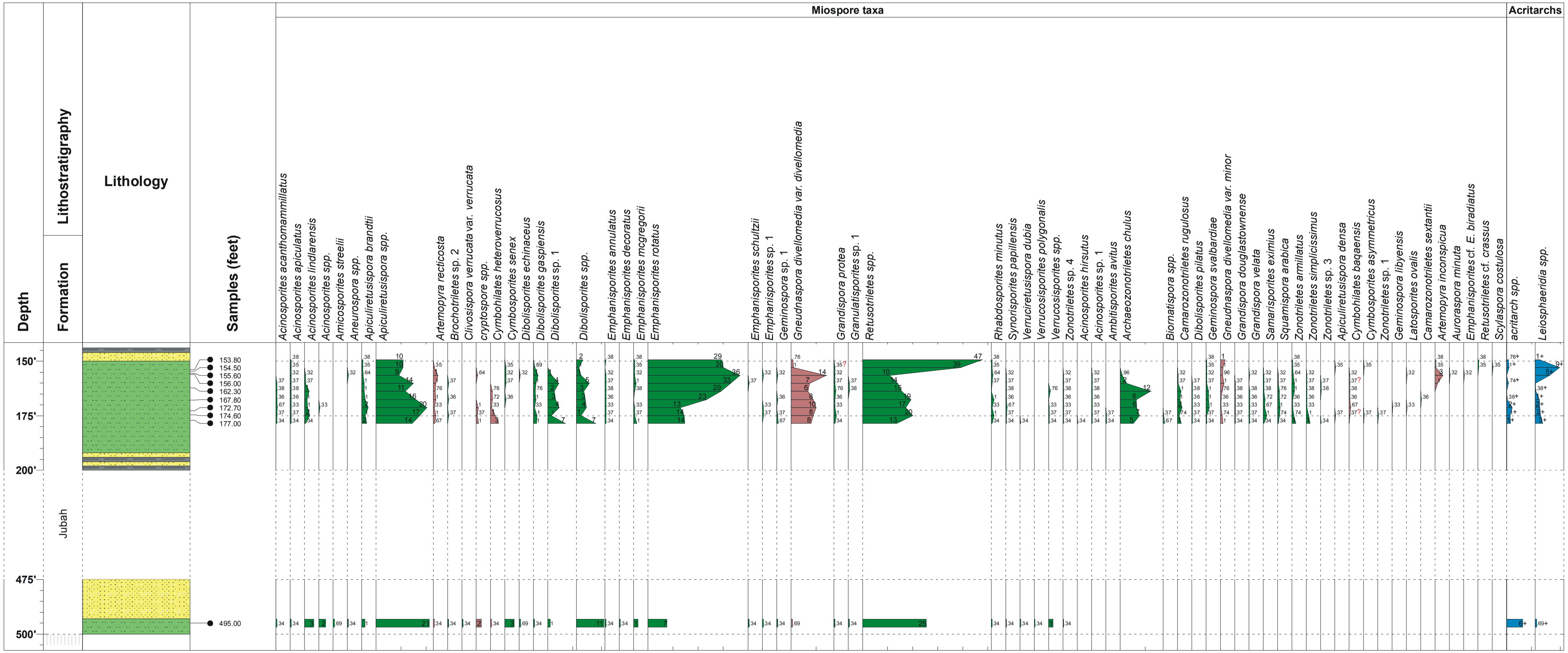

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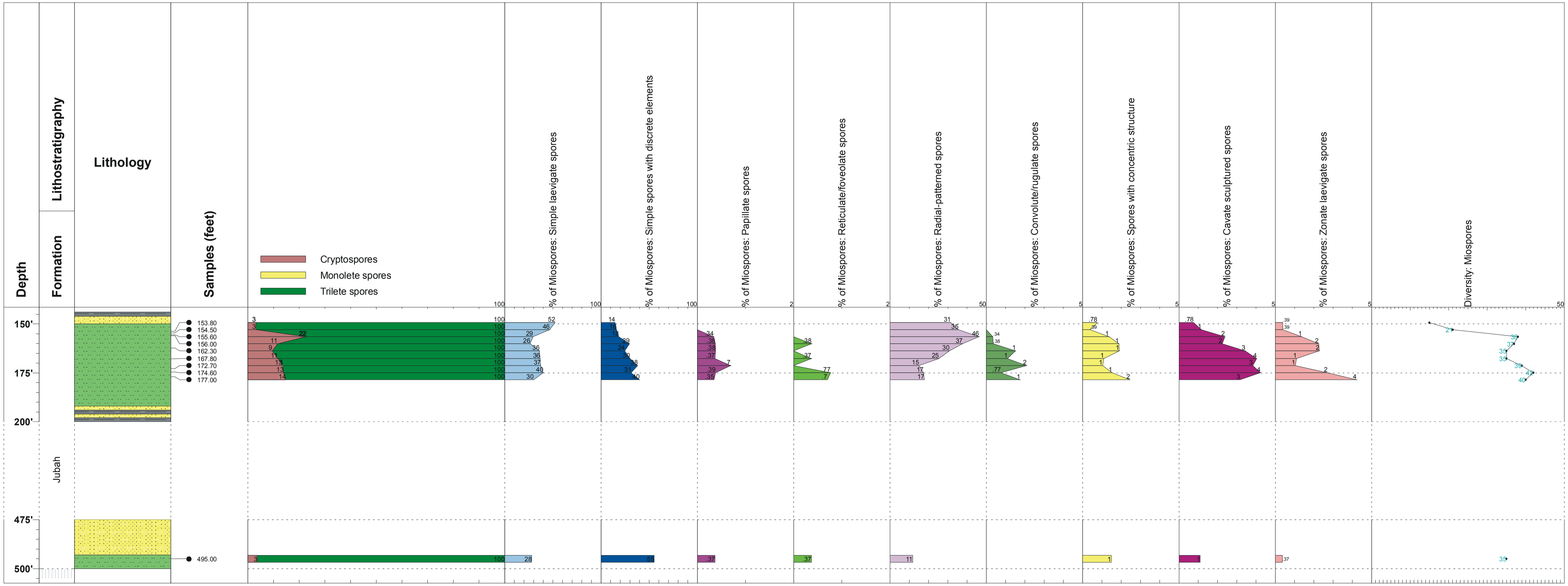

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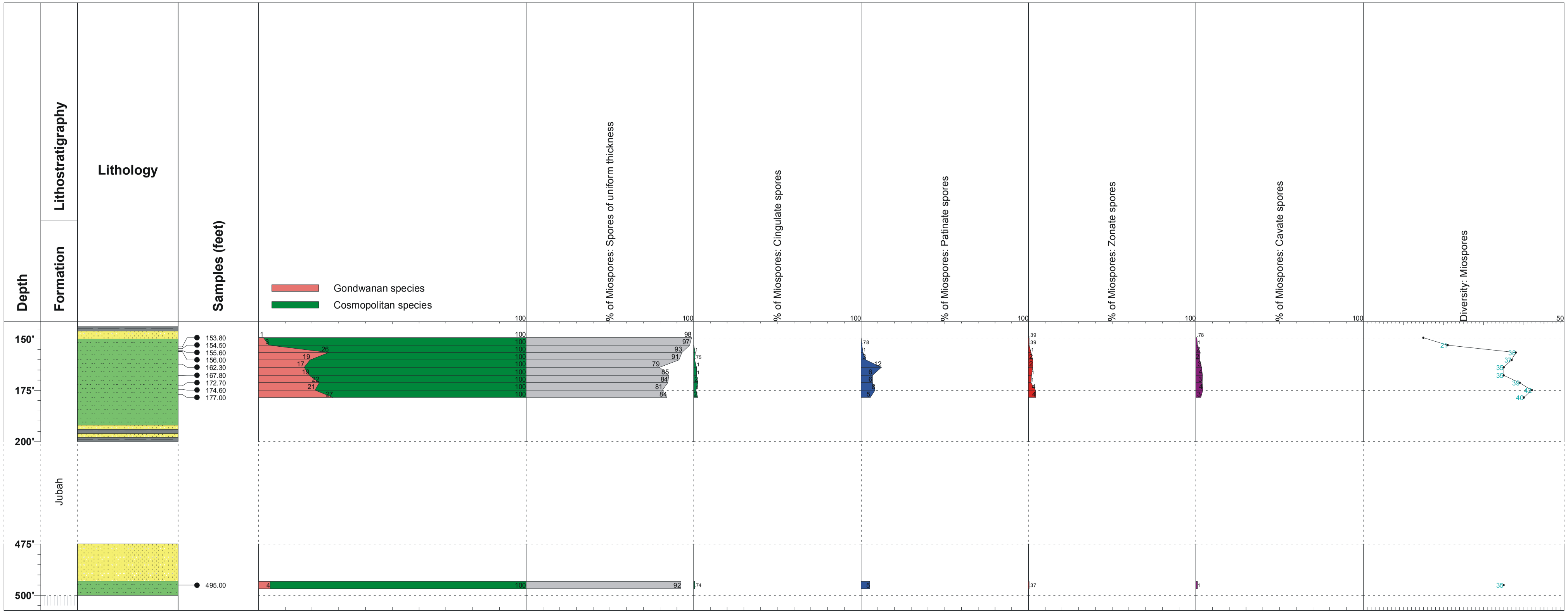

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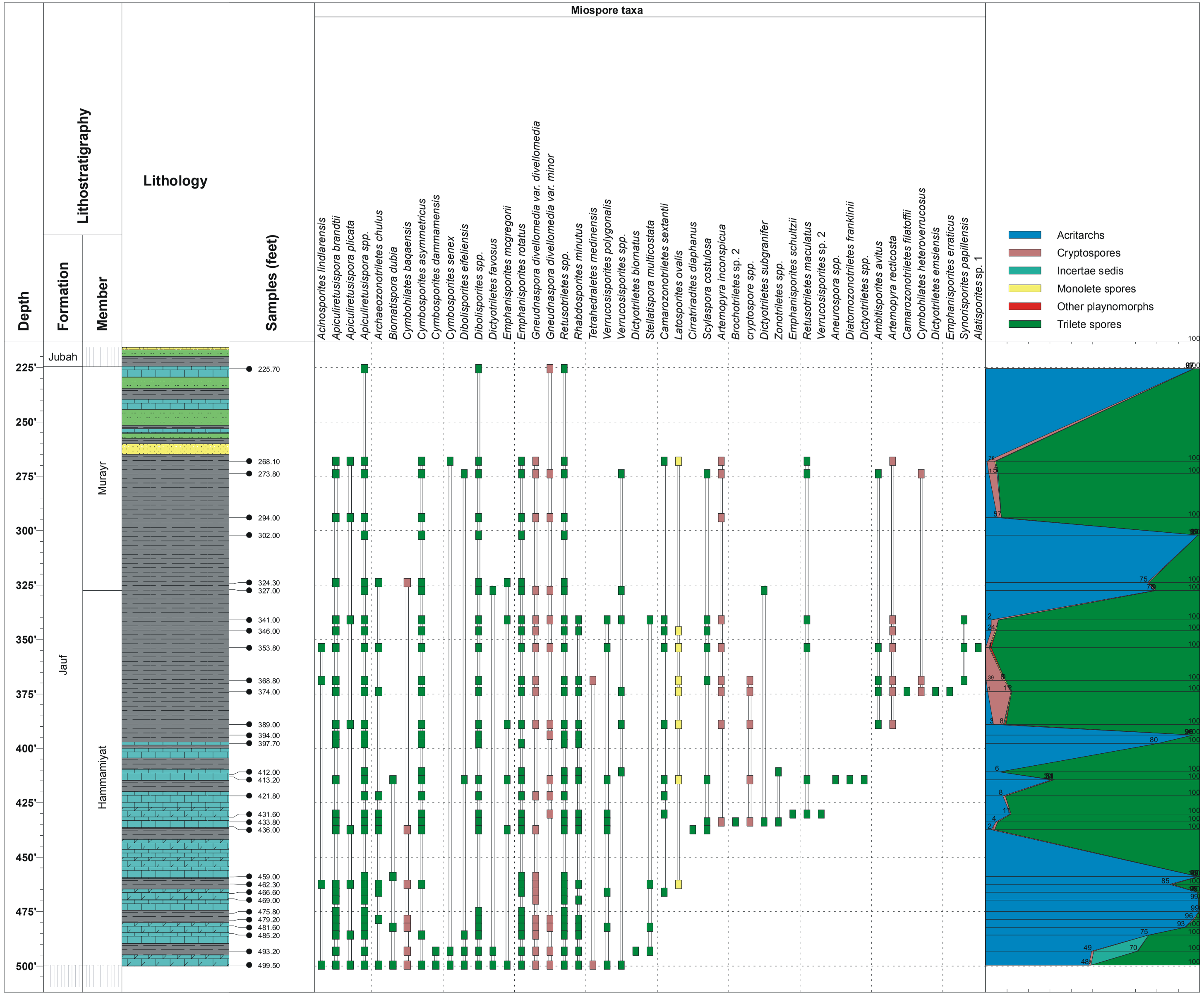

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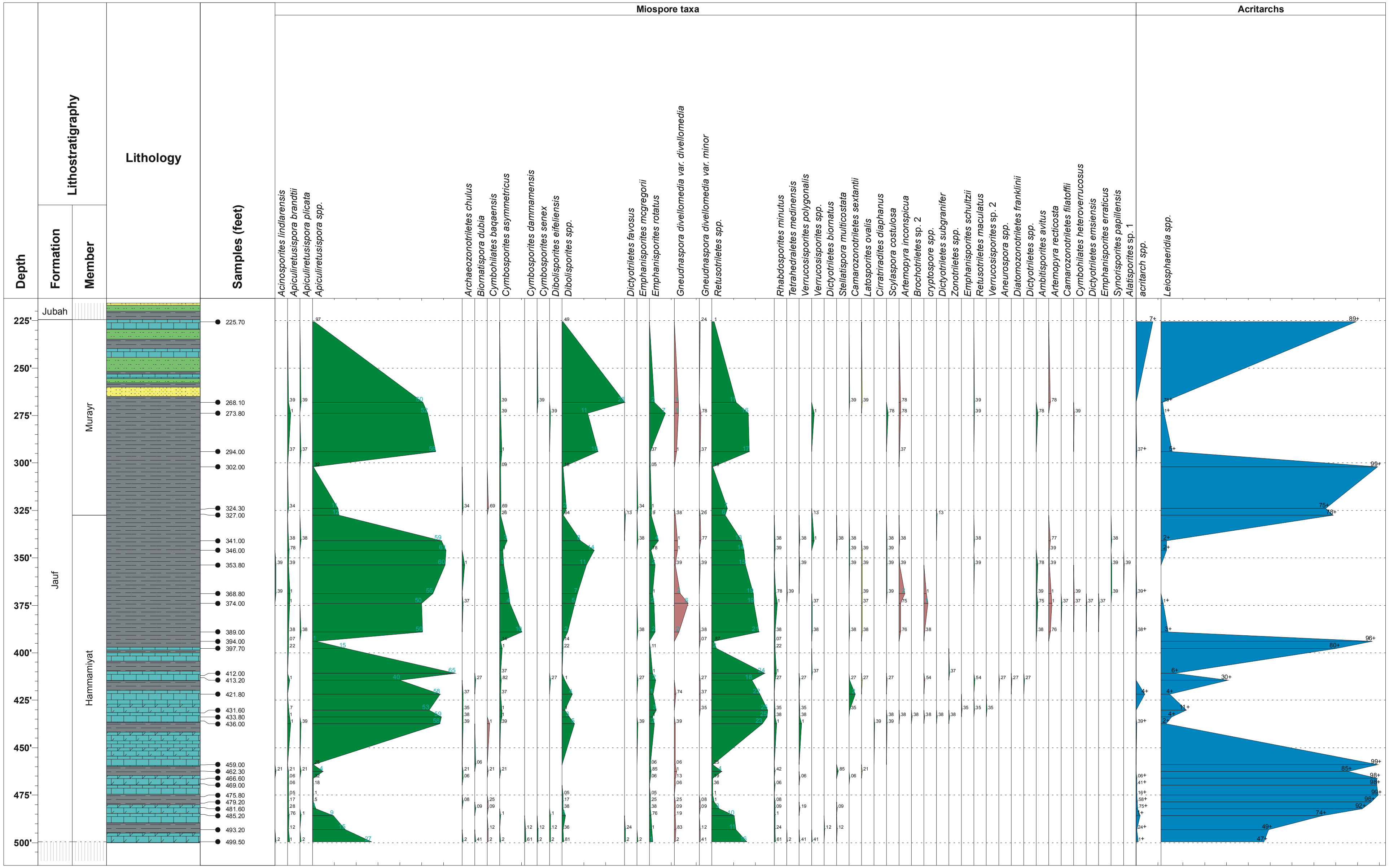
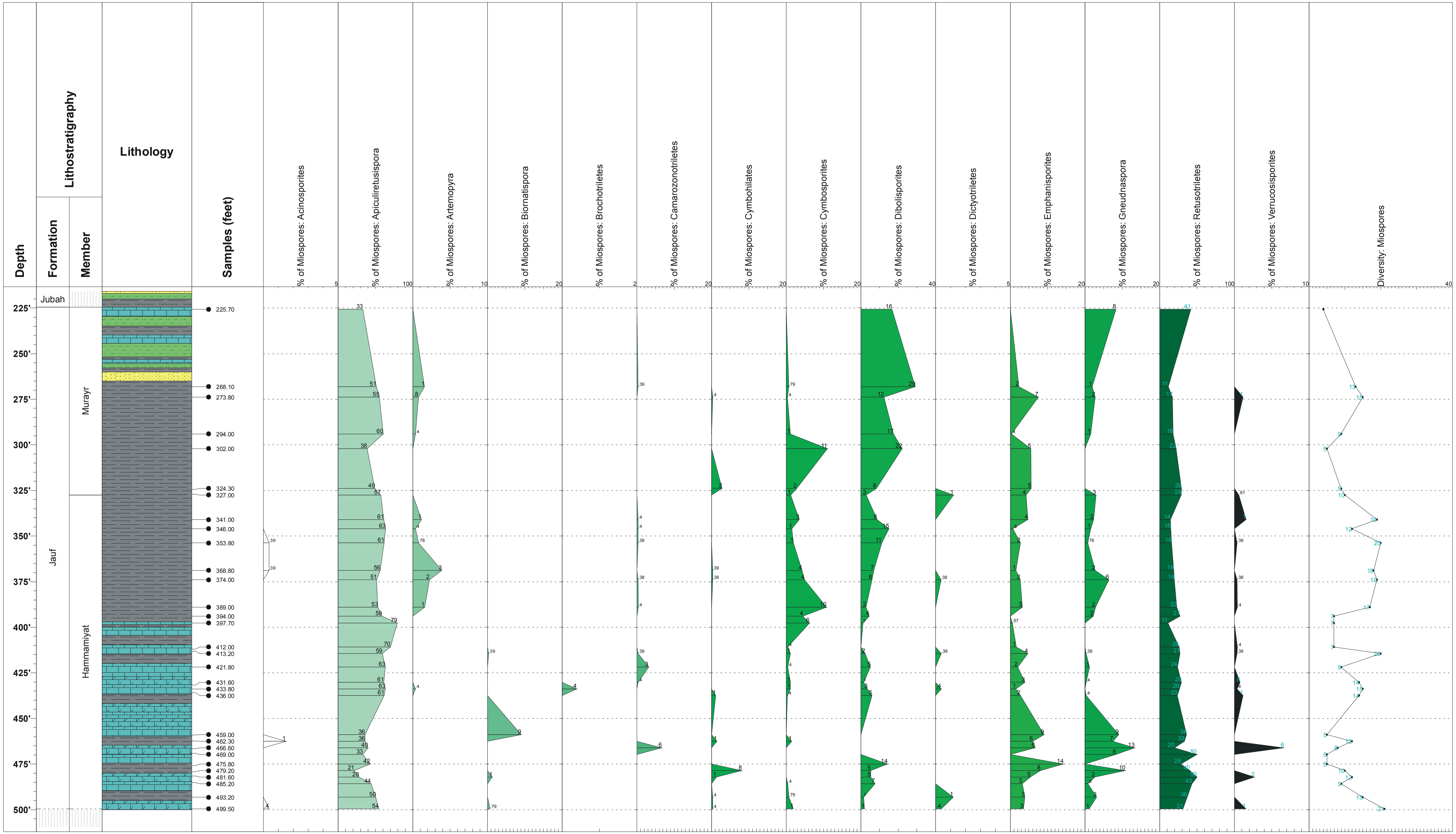


Fig. 2.23. Relative abundance of each individual taxon encountered in borehole JNDL-3.



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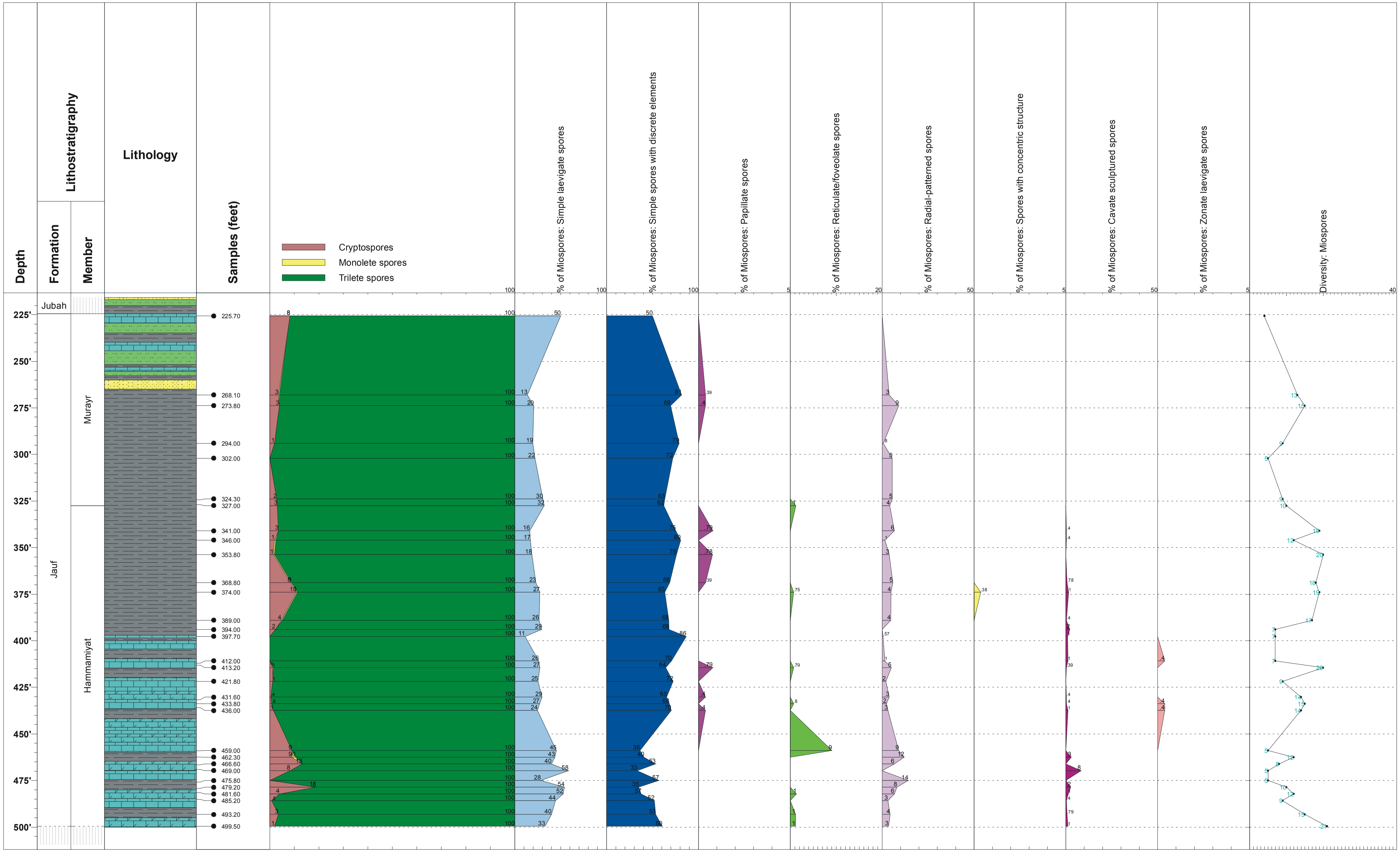

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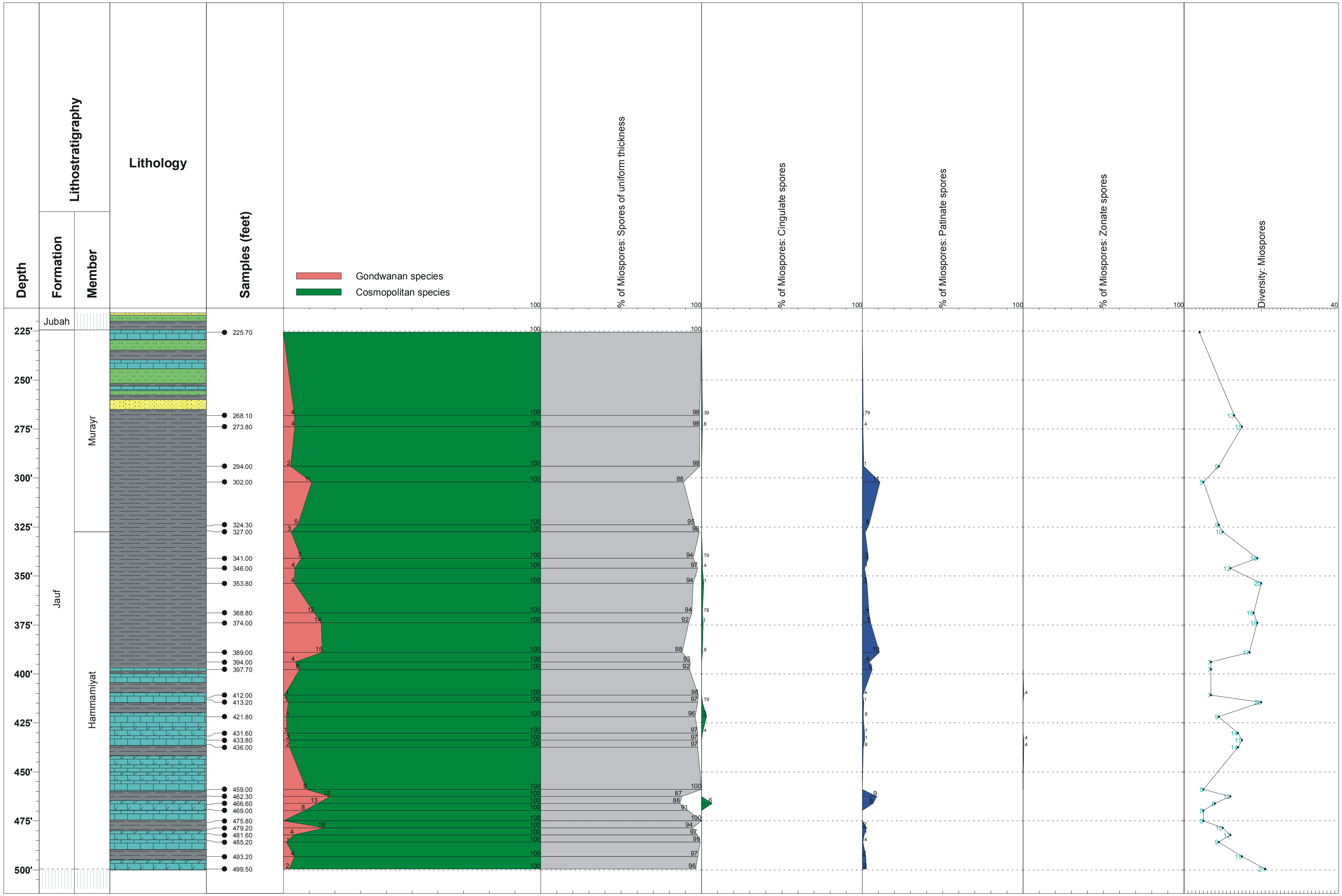

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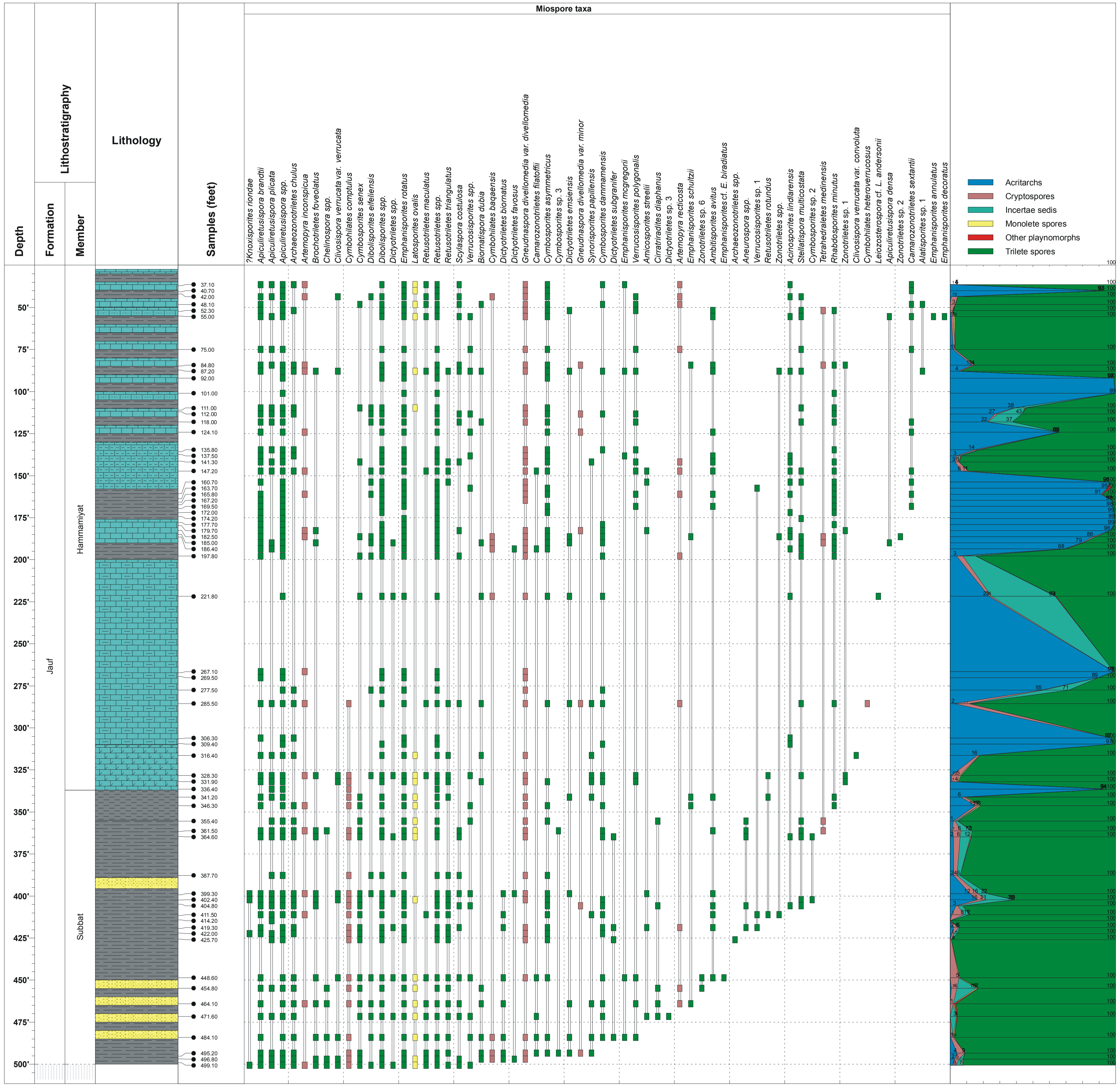

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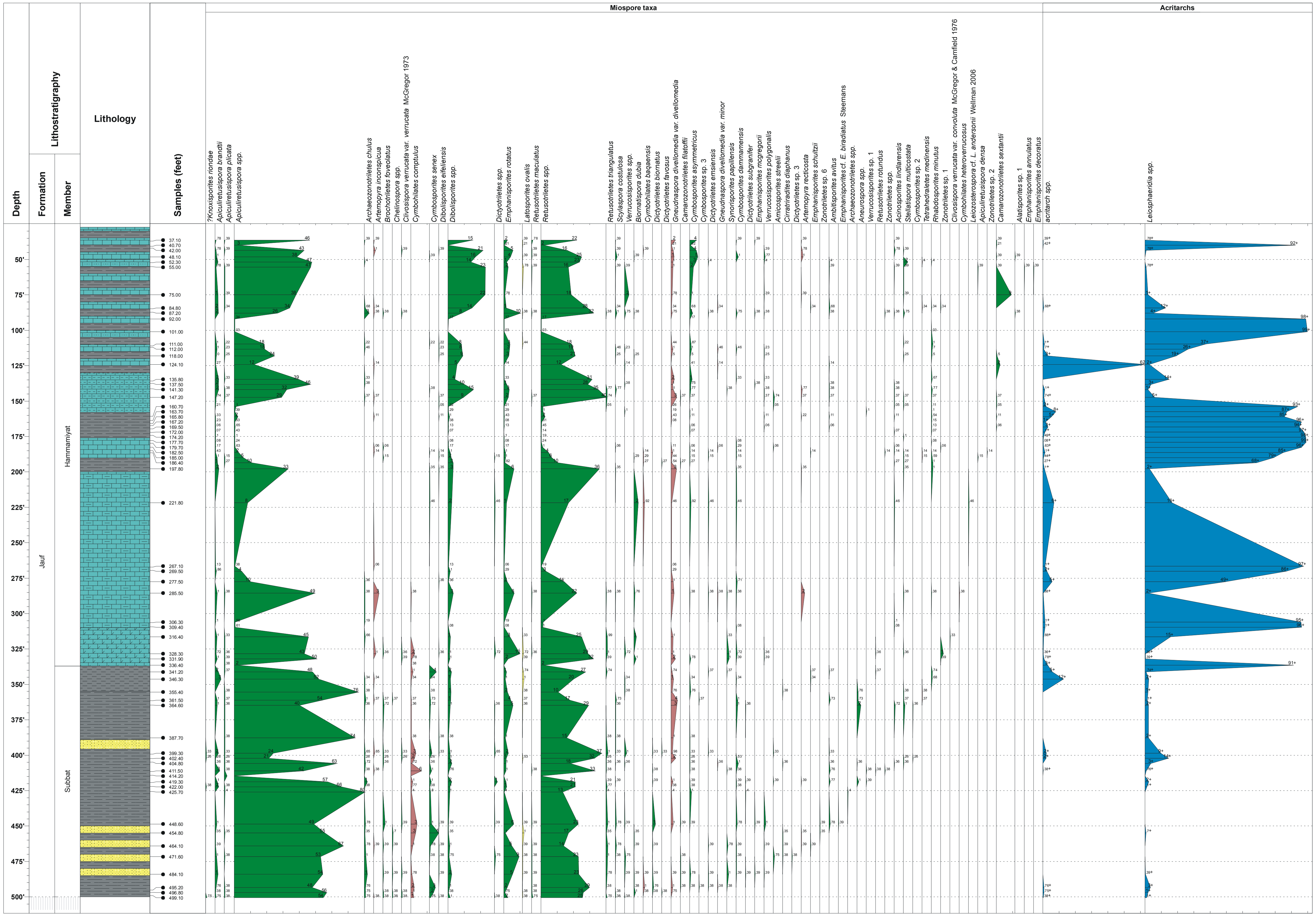

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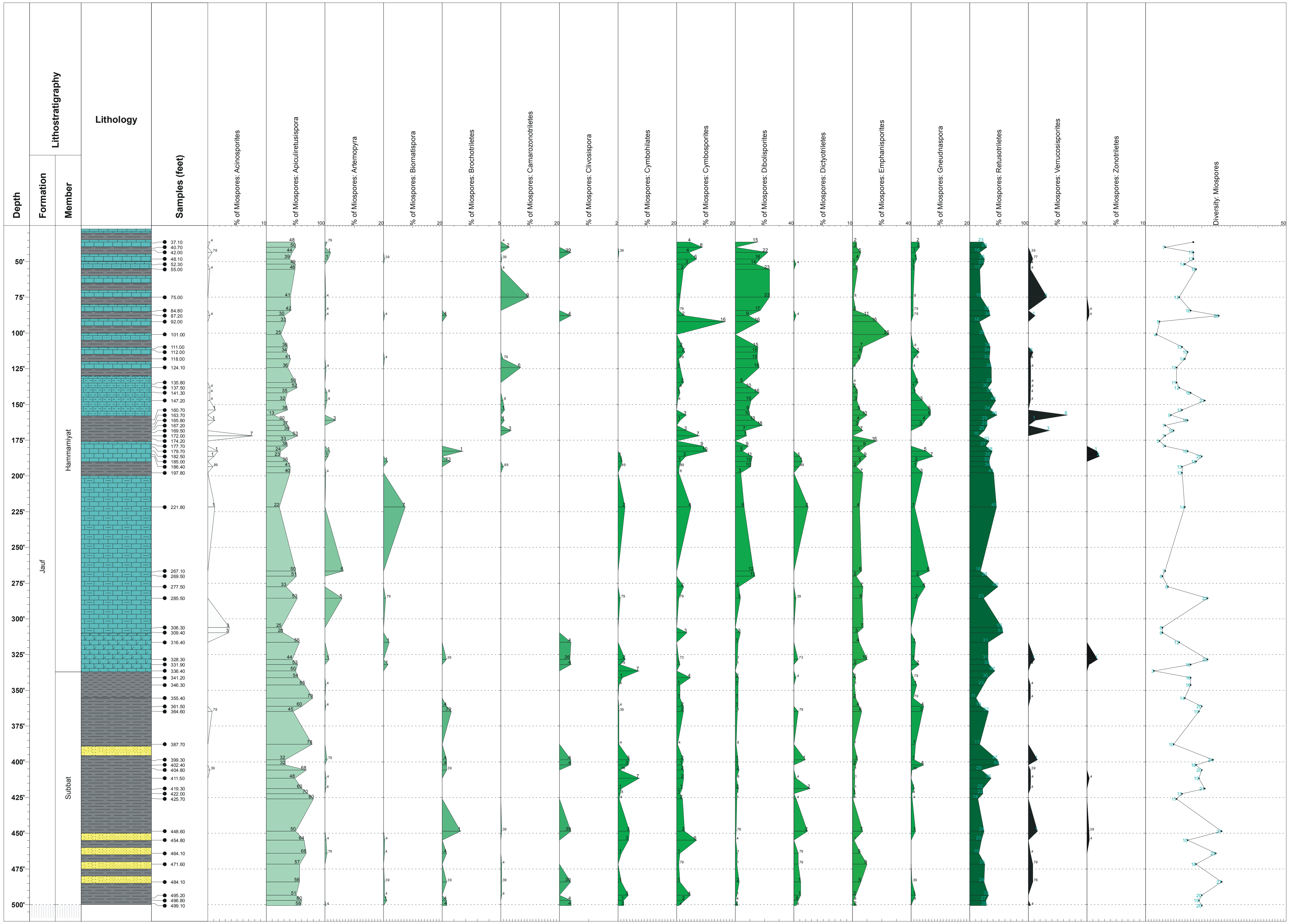

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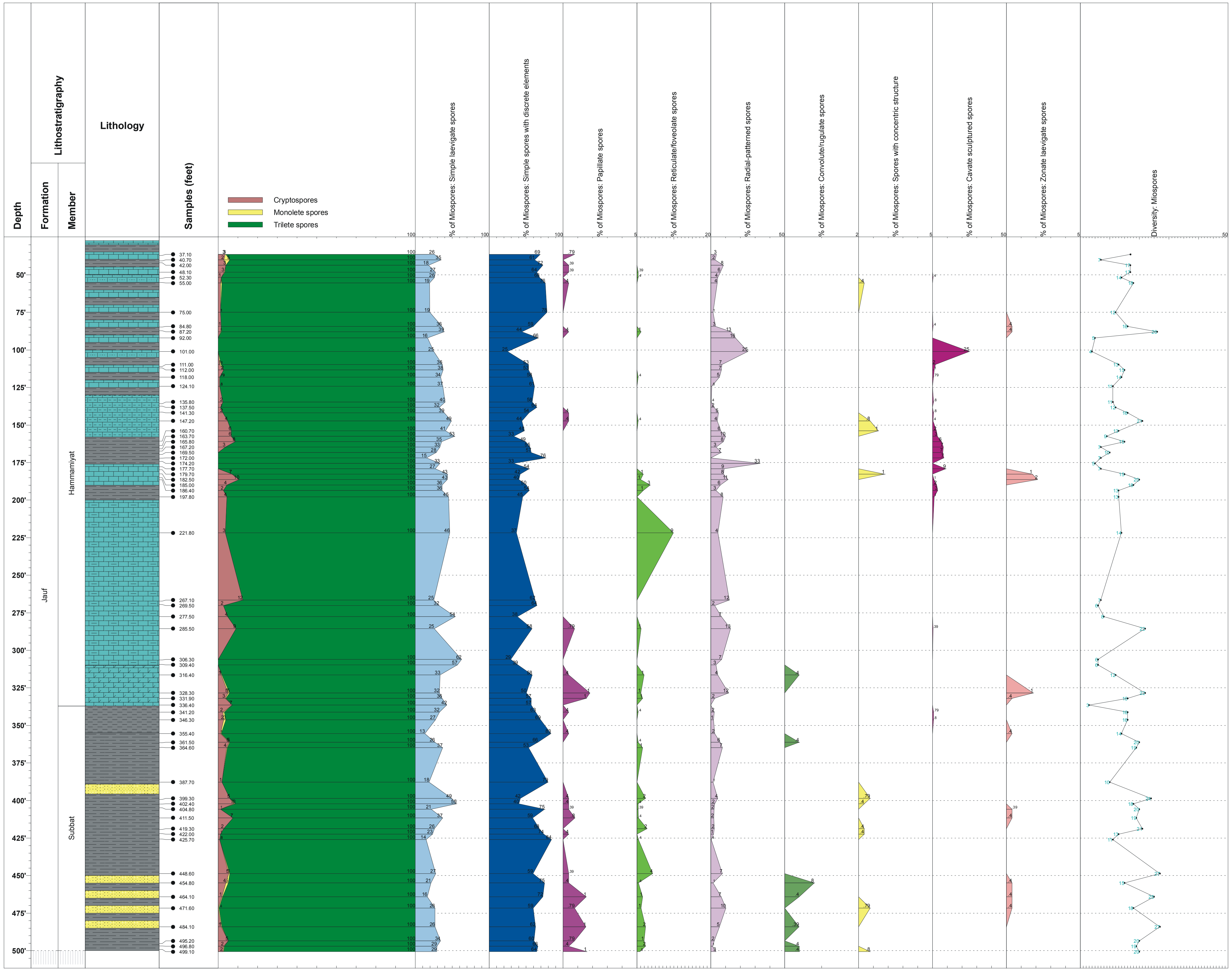

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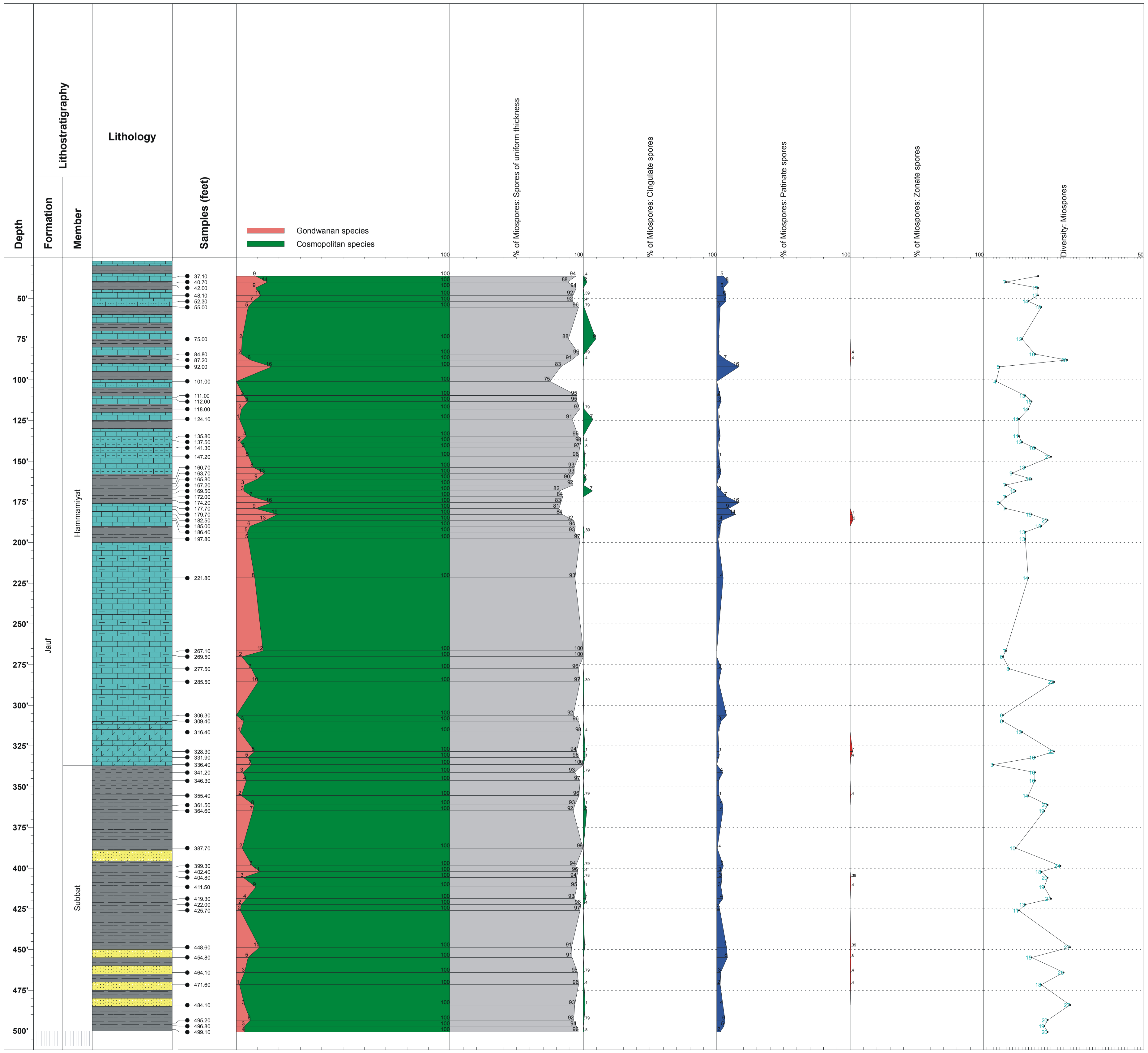

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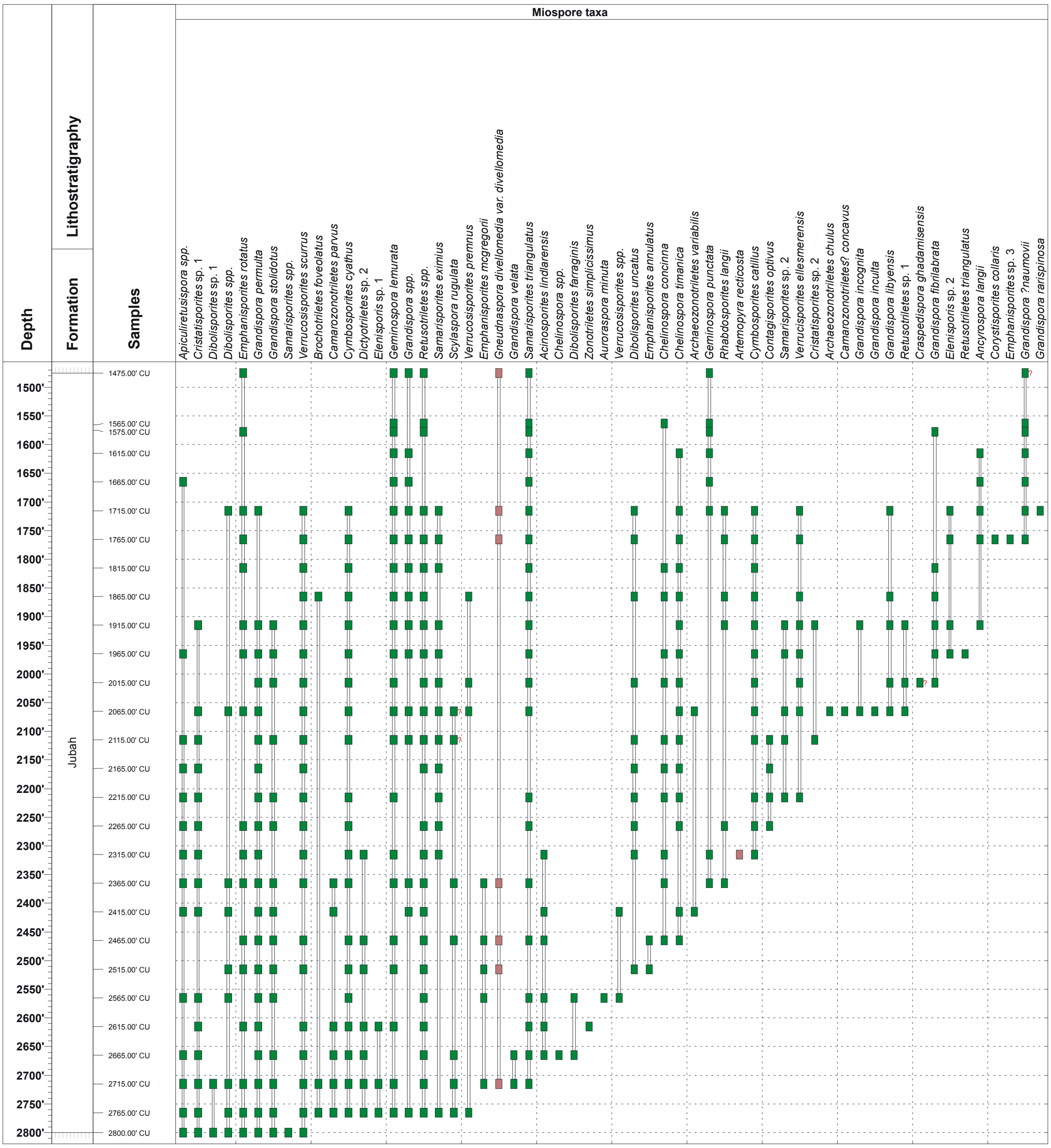

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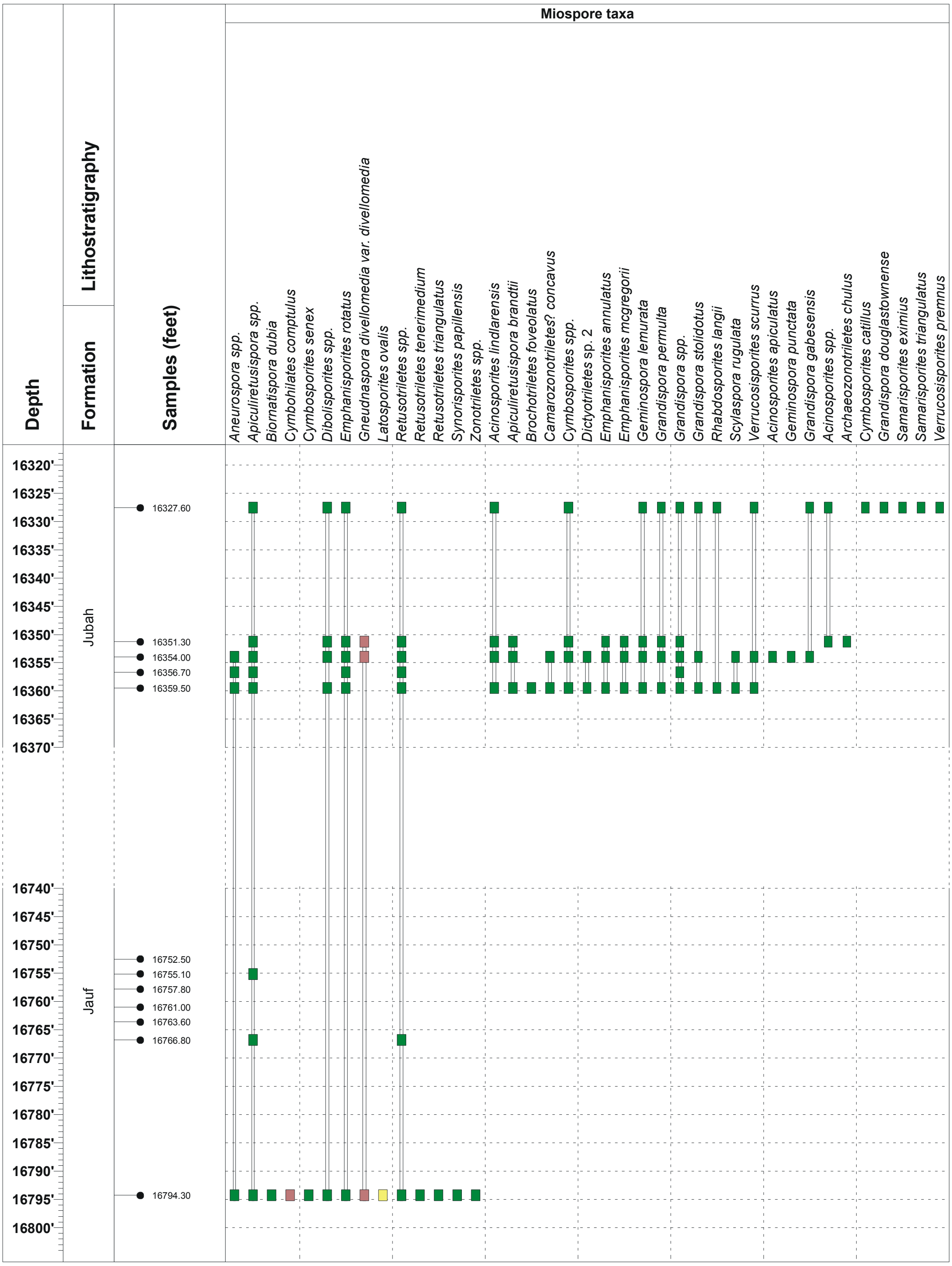

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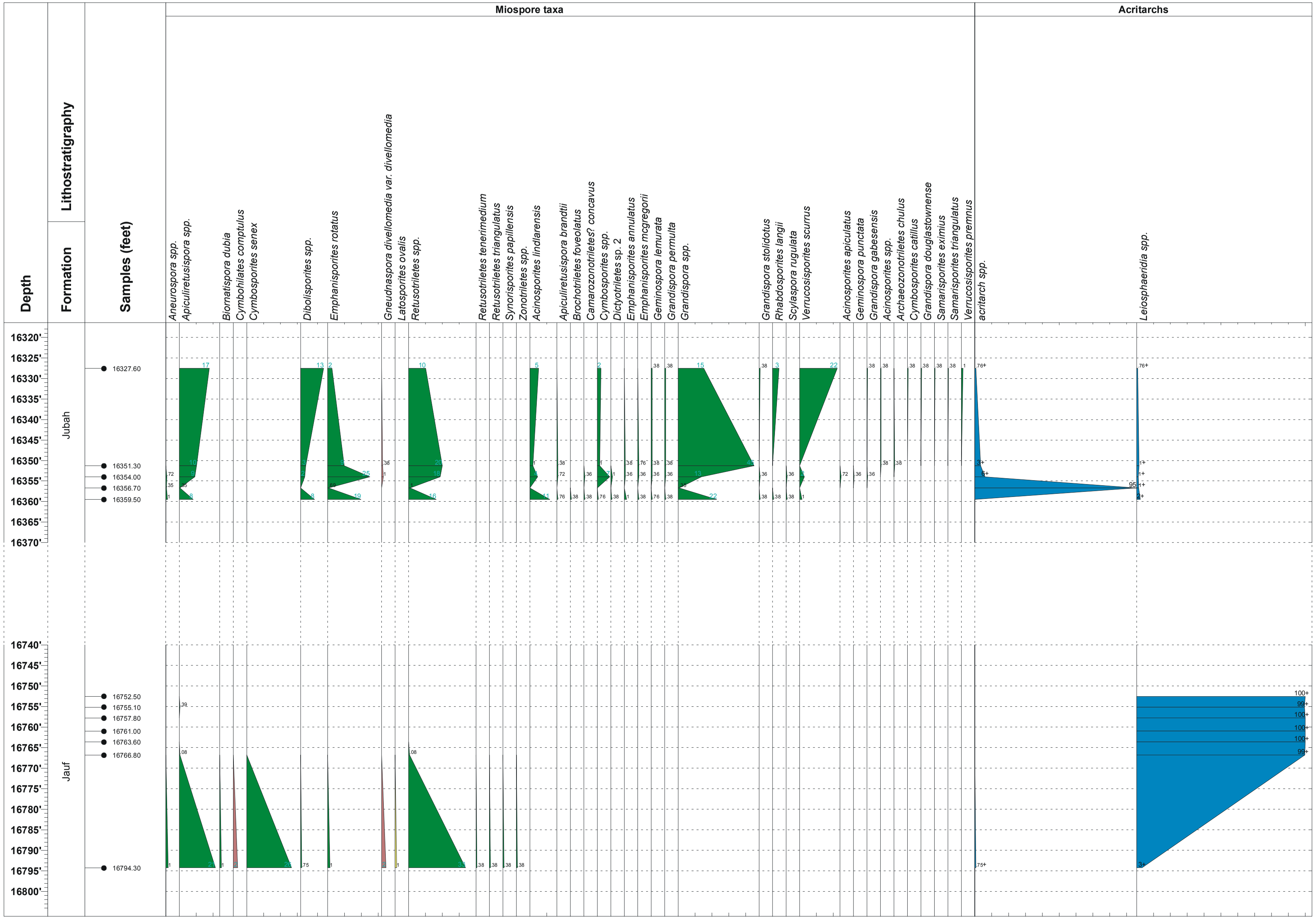

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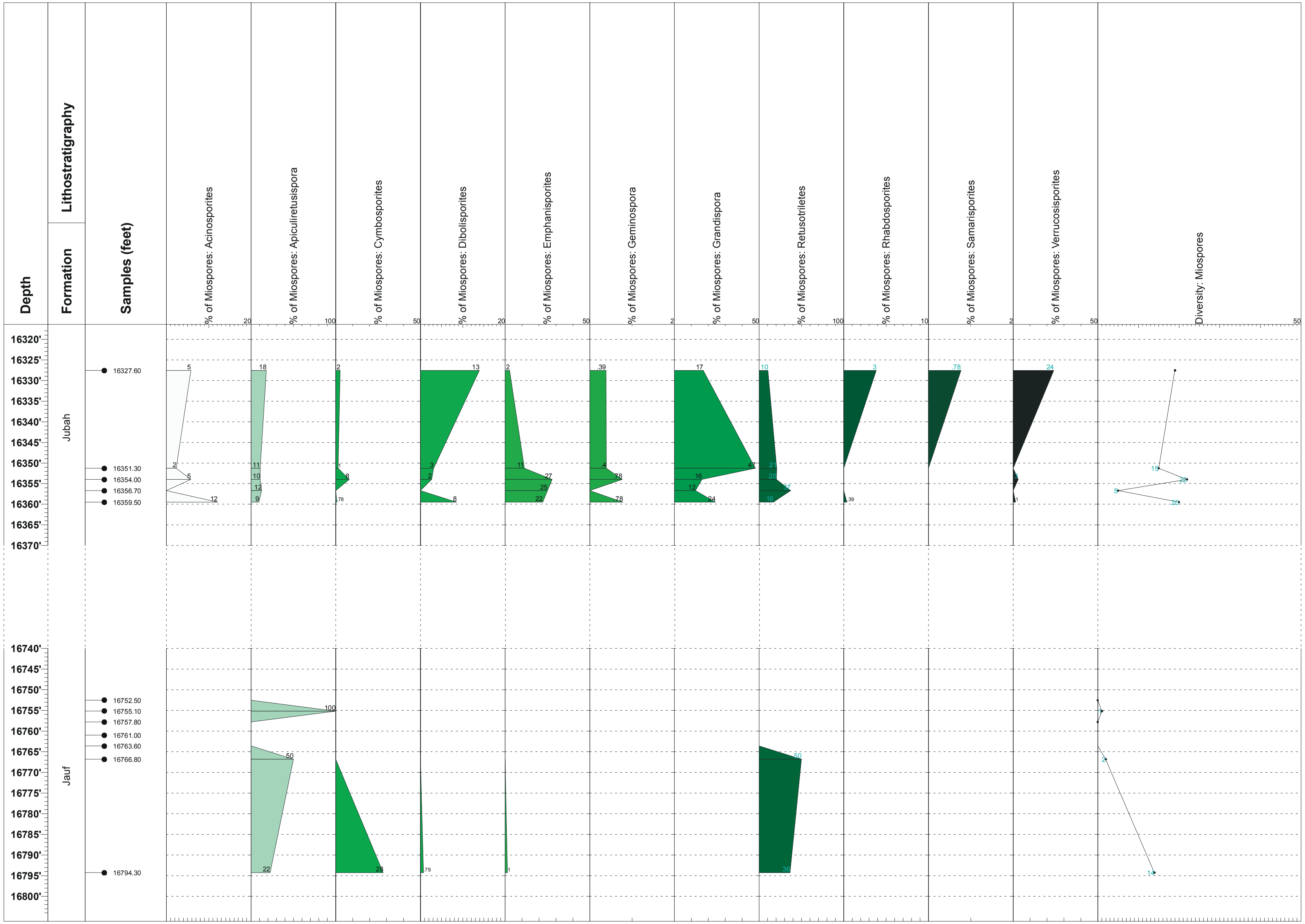
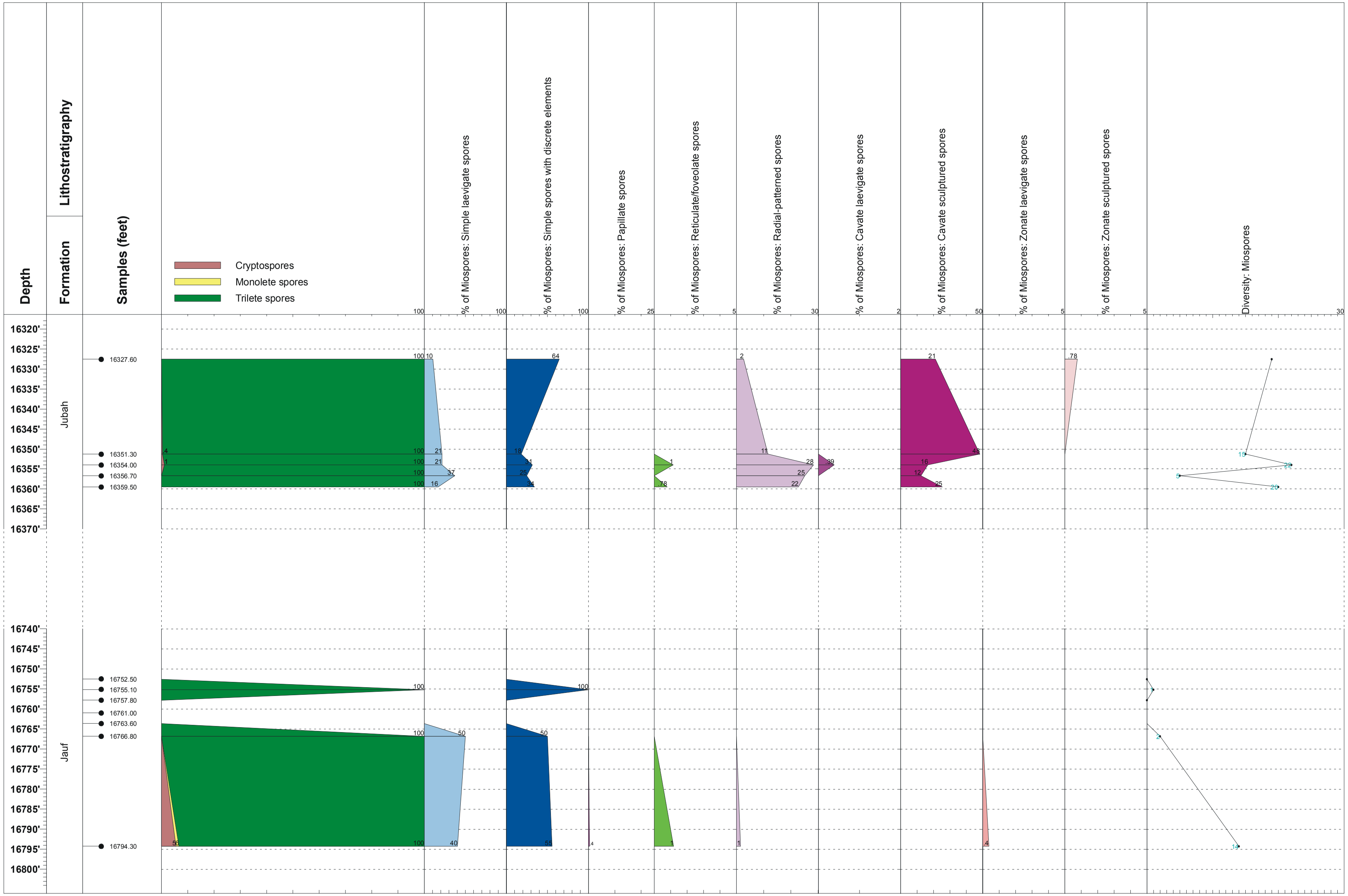


Fig. 2.35. Relative abundance of the main miospore genera encountered in well ABSF-29.



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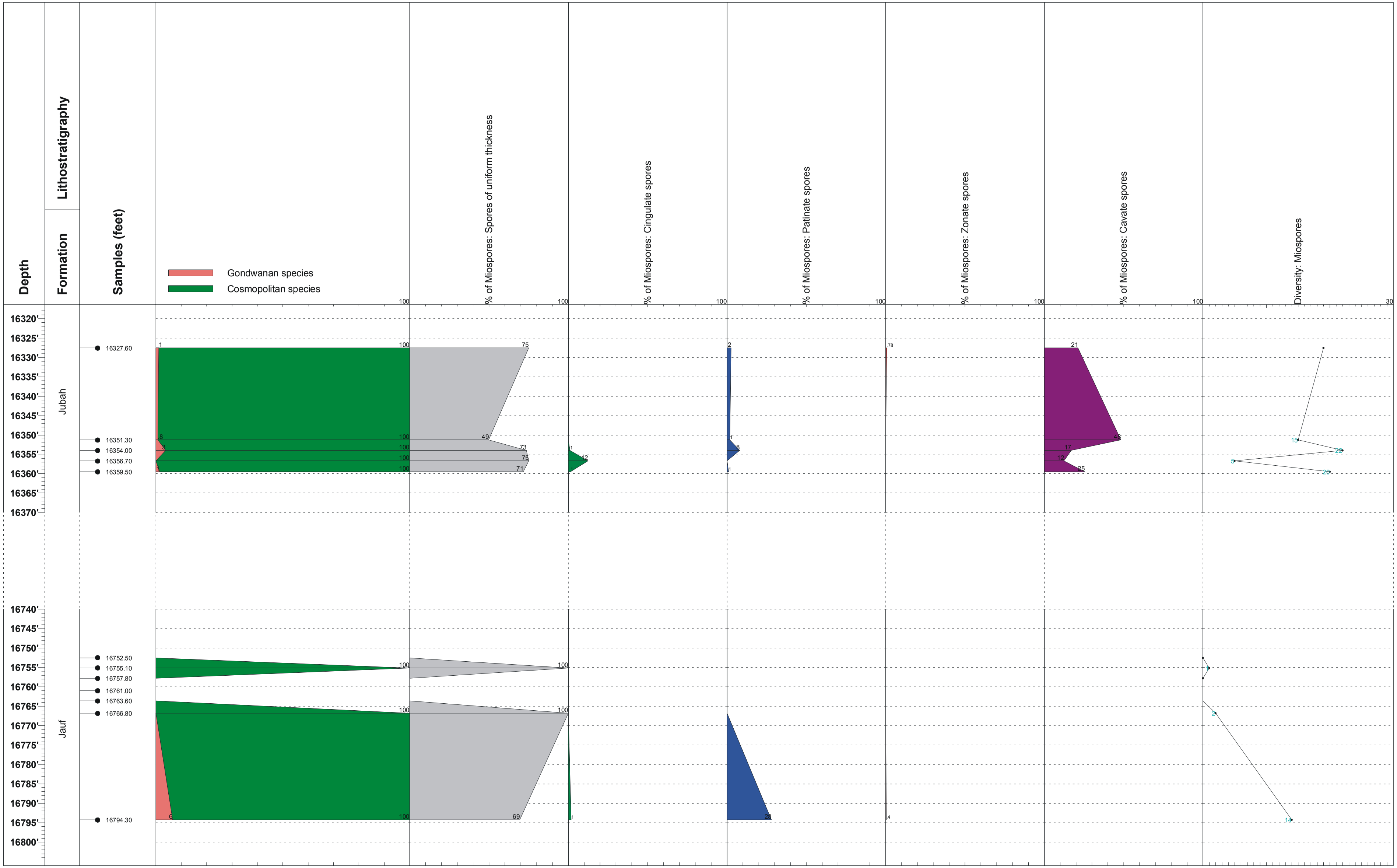

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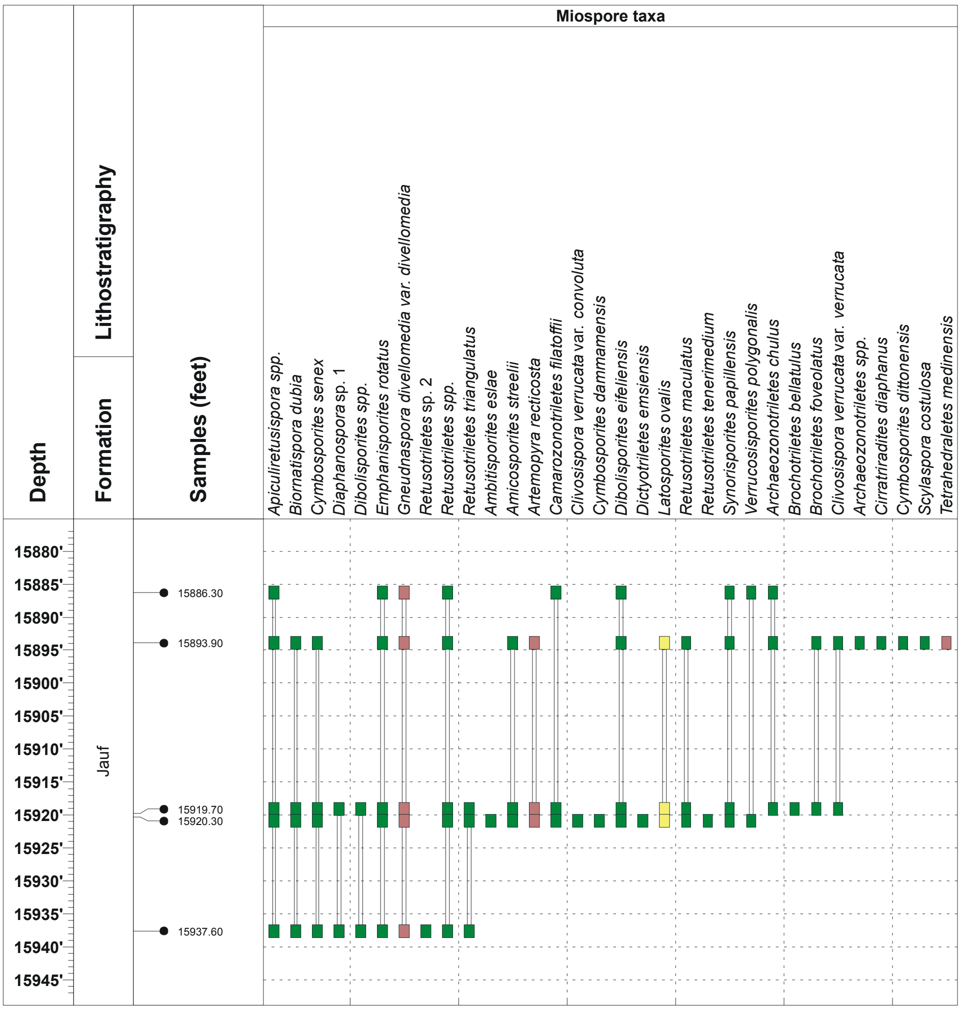

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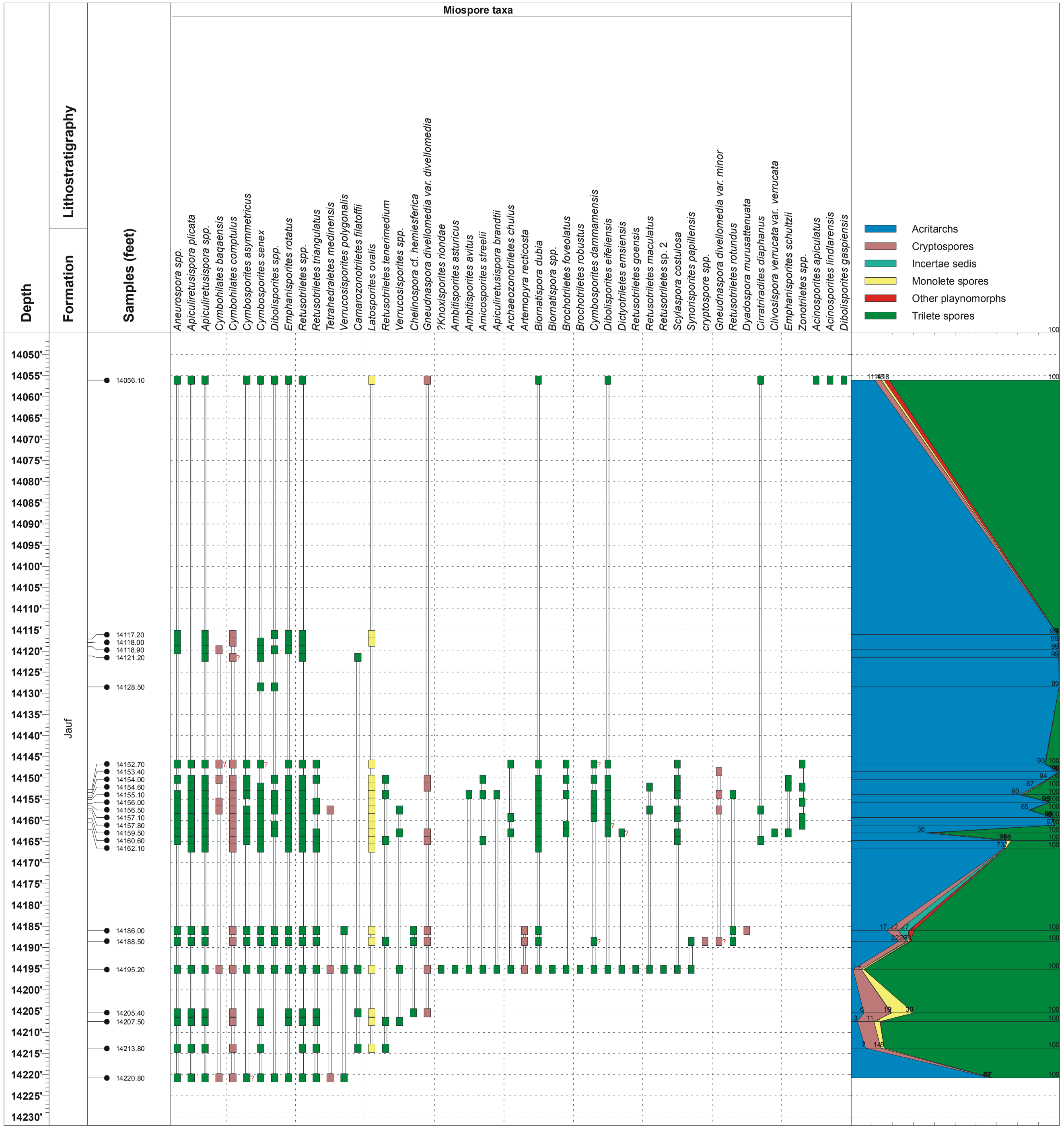


Fig. 2.39. Stratigraphic ranges of miospores encountered in well HWYH-956.

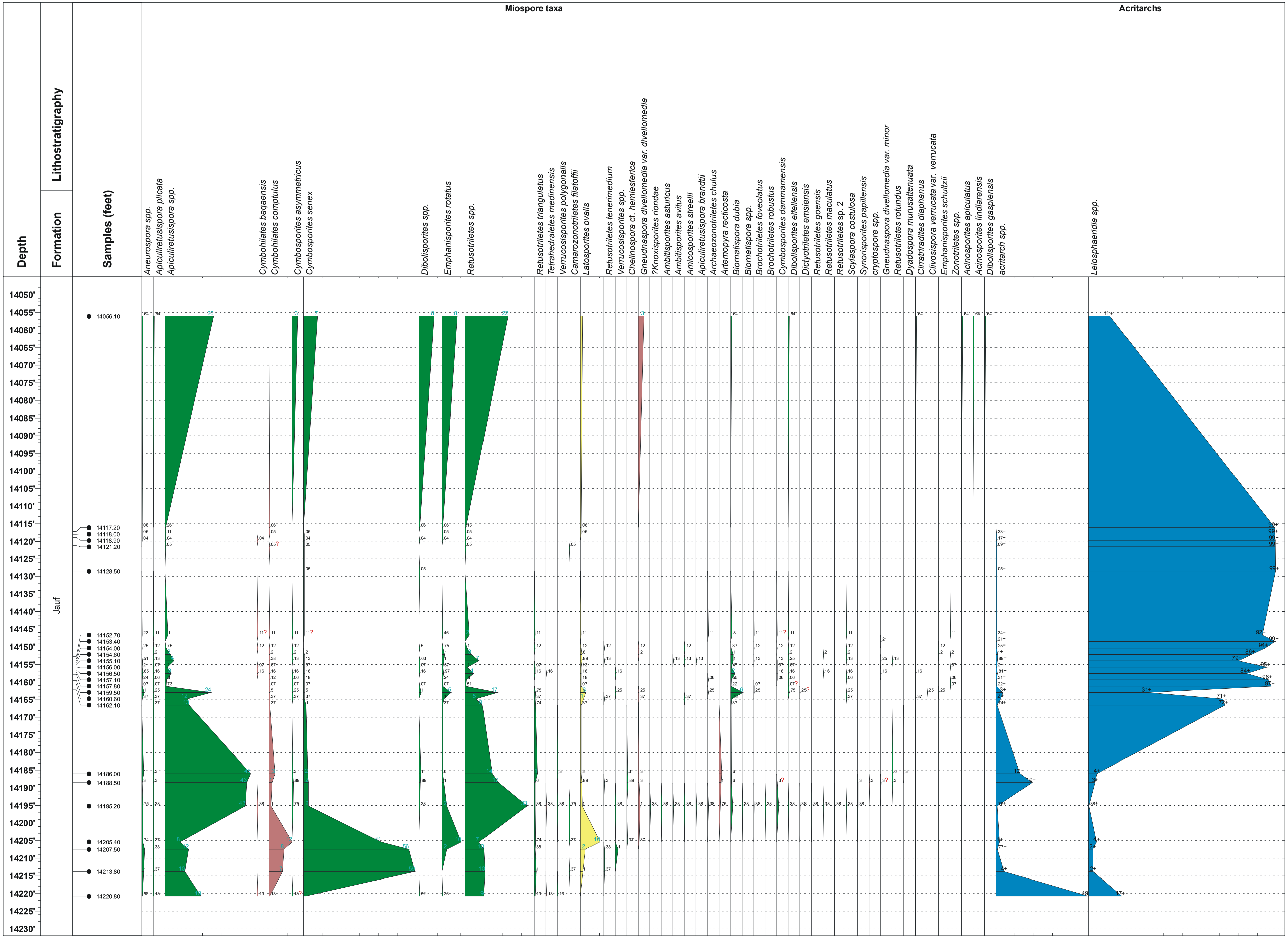
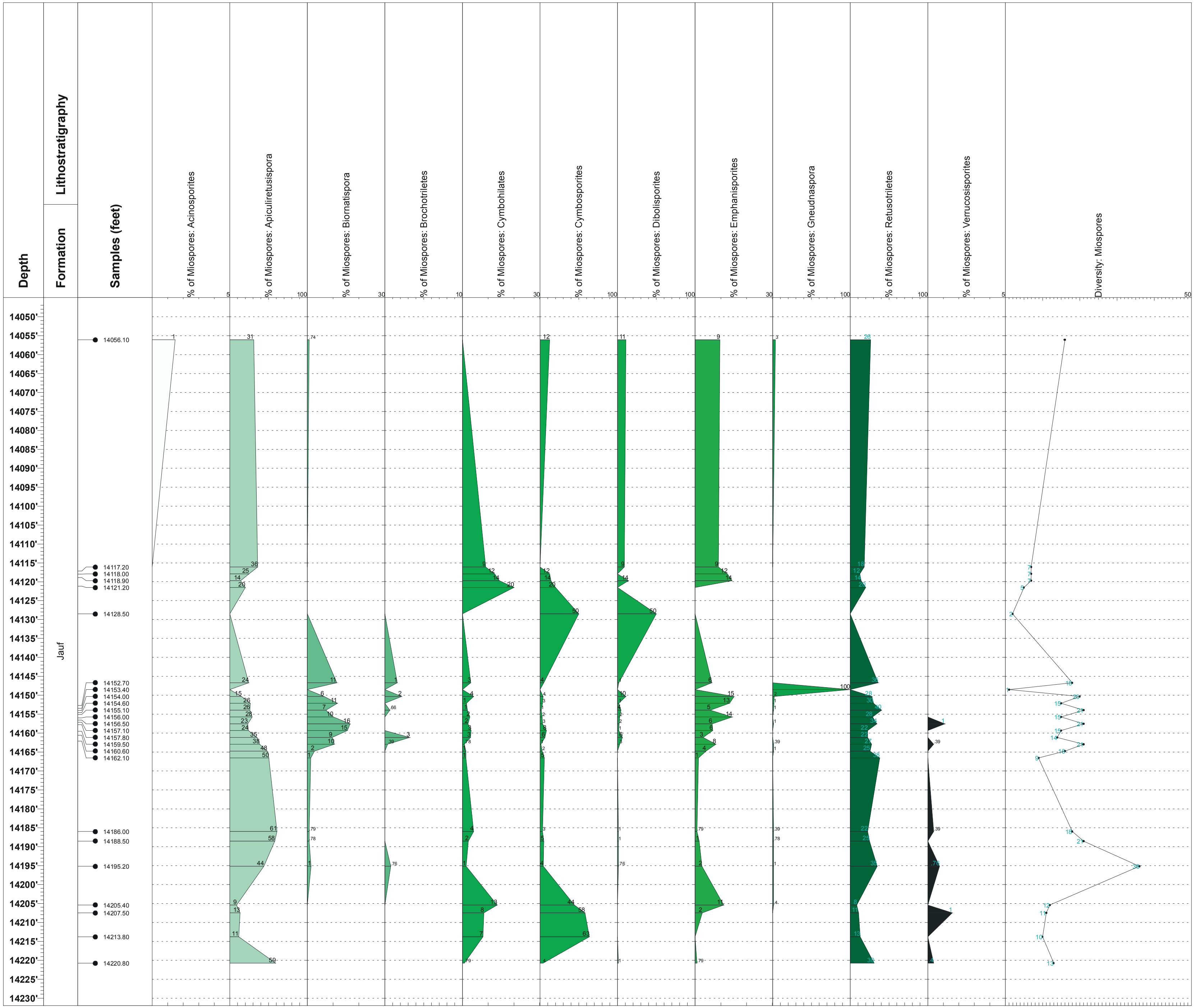


Fig. 2.40. Relative abundance of each individual taxon encountered in well HWYH-956.



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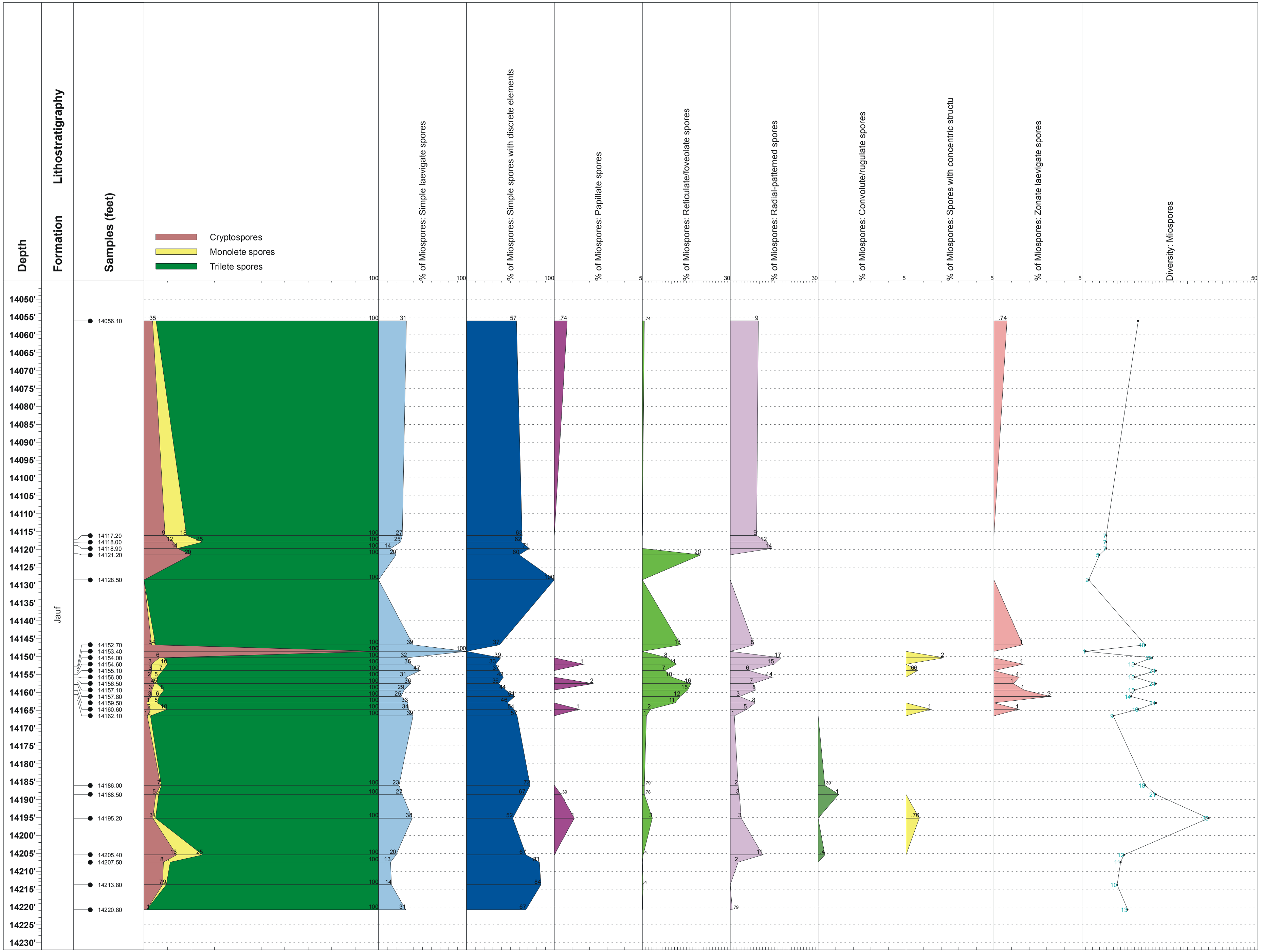


Fig. 2.42. Relative abundance of the main different miospore morphological groups encountered in HWYH-956.

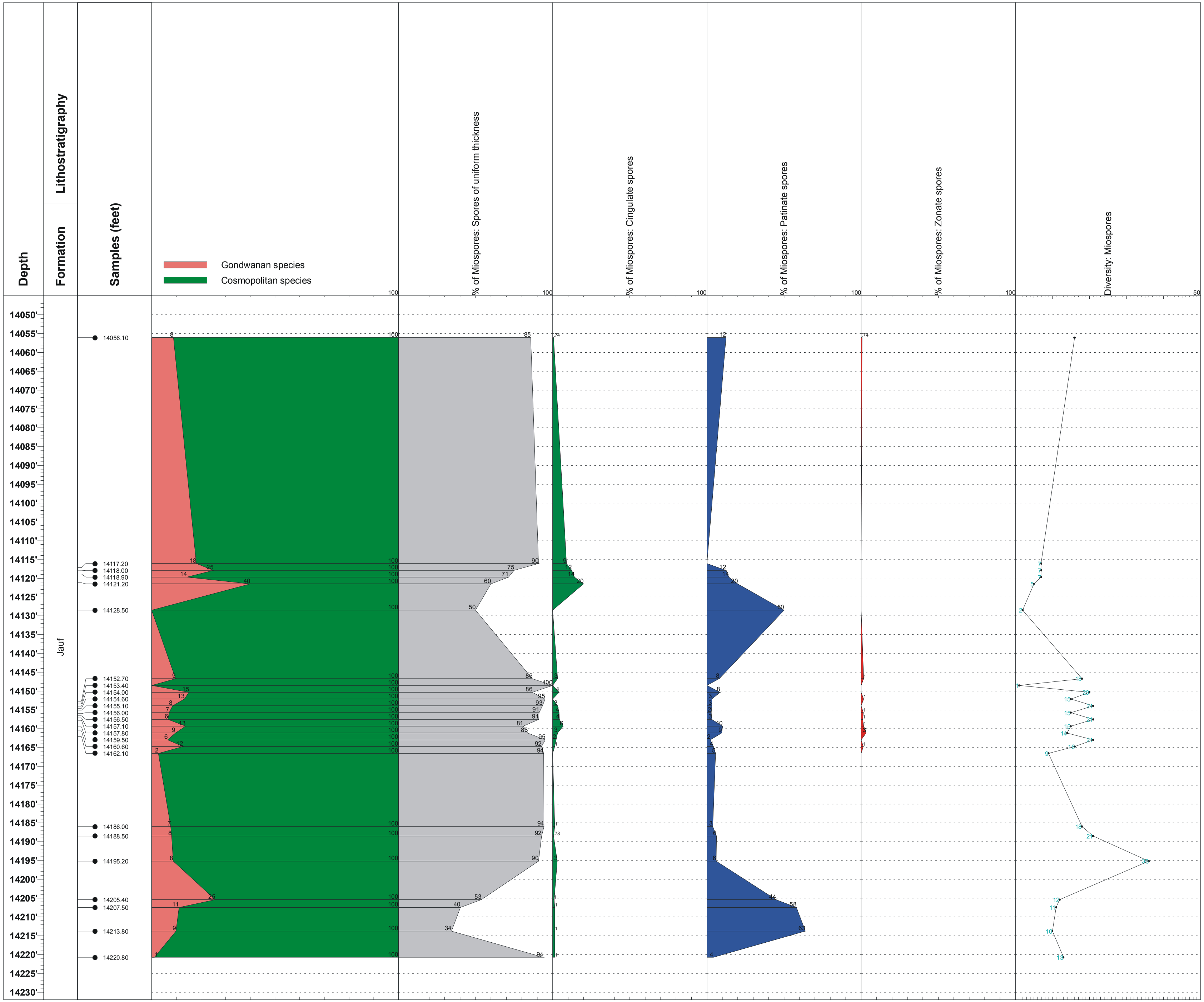


Fig. 2.43. Relative abundance of the miospore groups according to their palaeogeographic affinity in well HWYH-956 on the left and relative abundance of the different miospore structure groups.

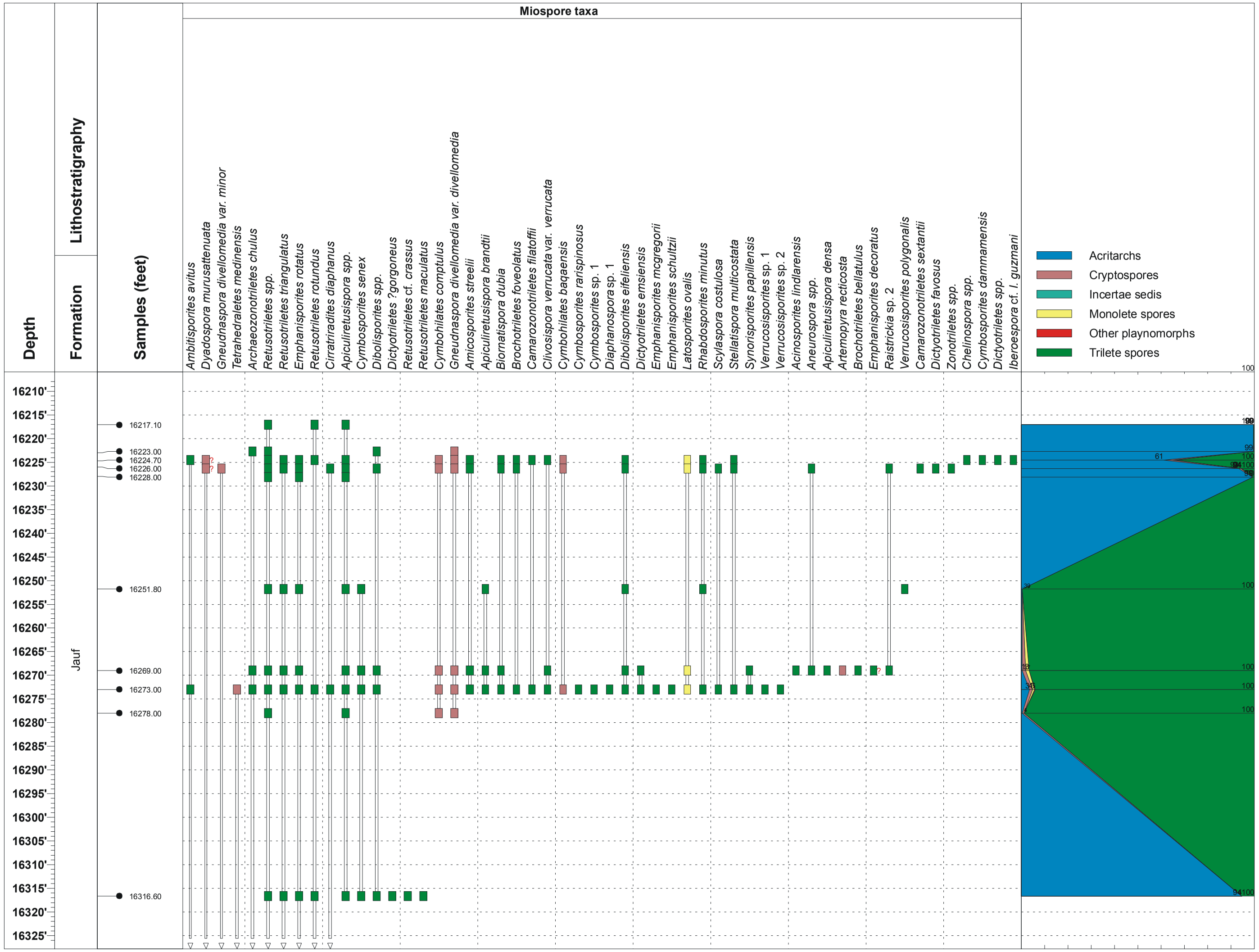
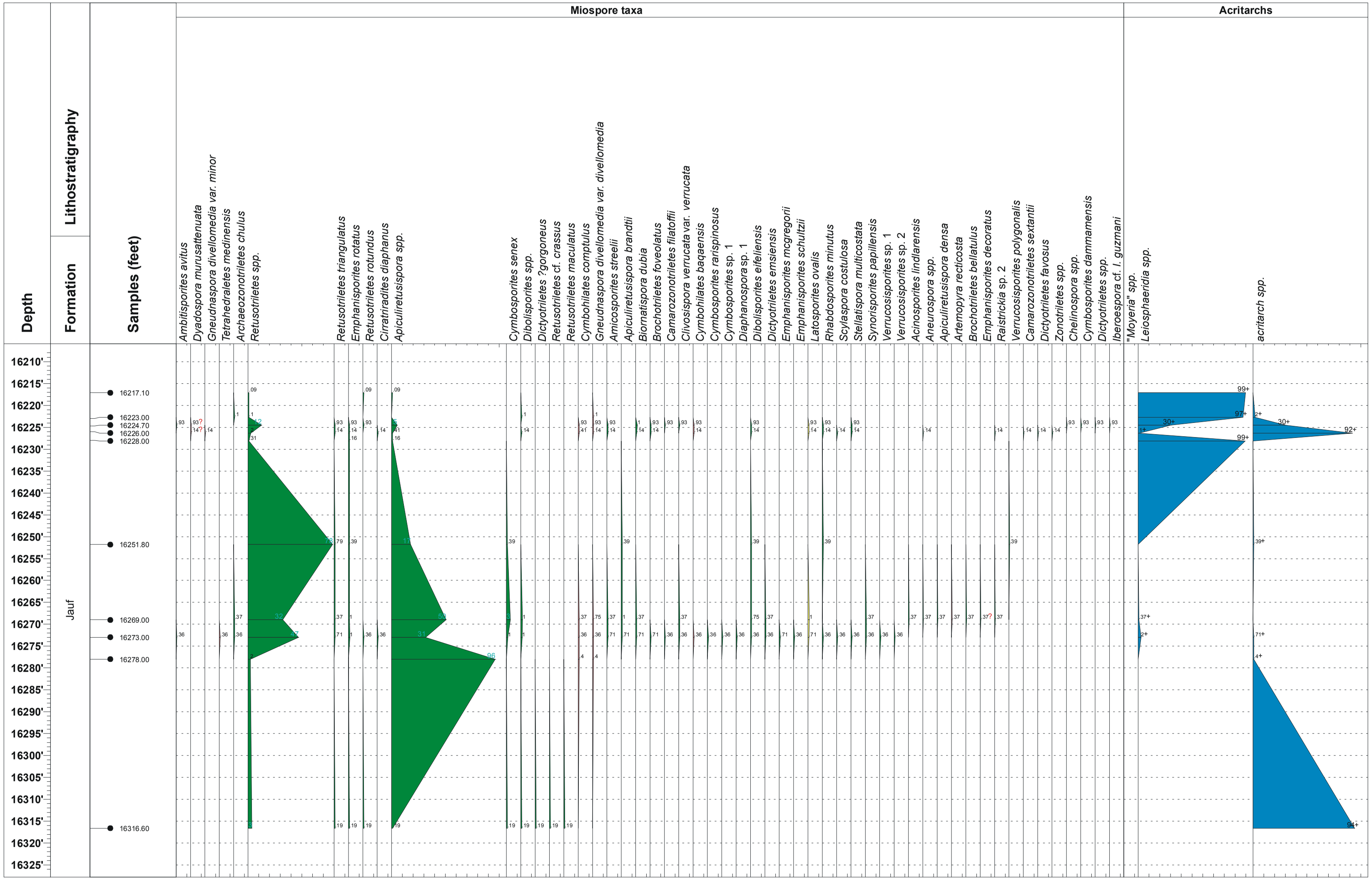


Fig. 2.44. Stratigraphic ranges of miospores encountered in well KHRM-2.



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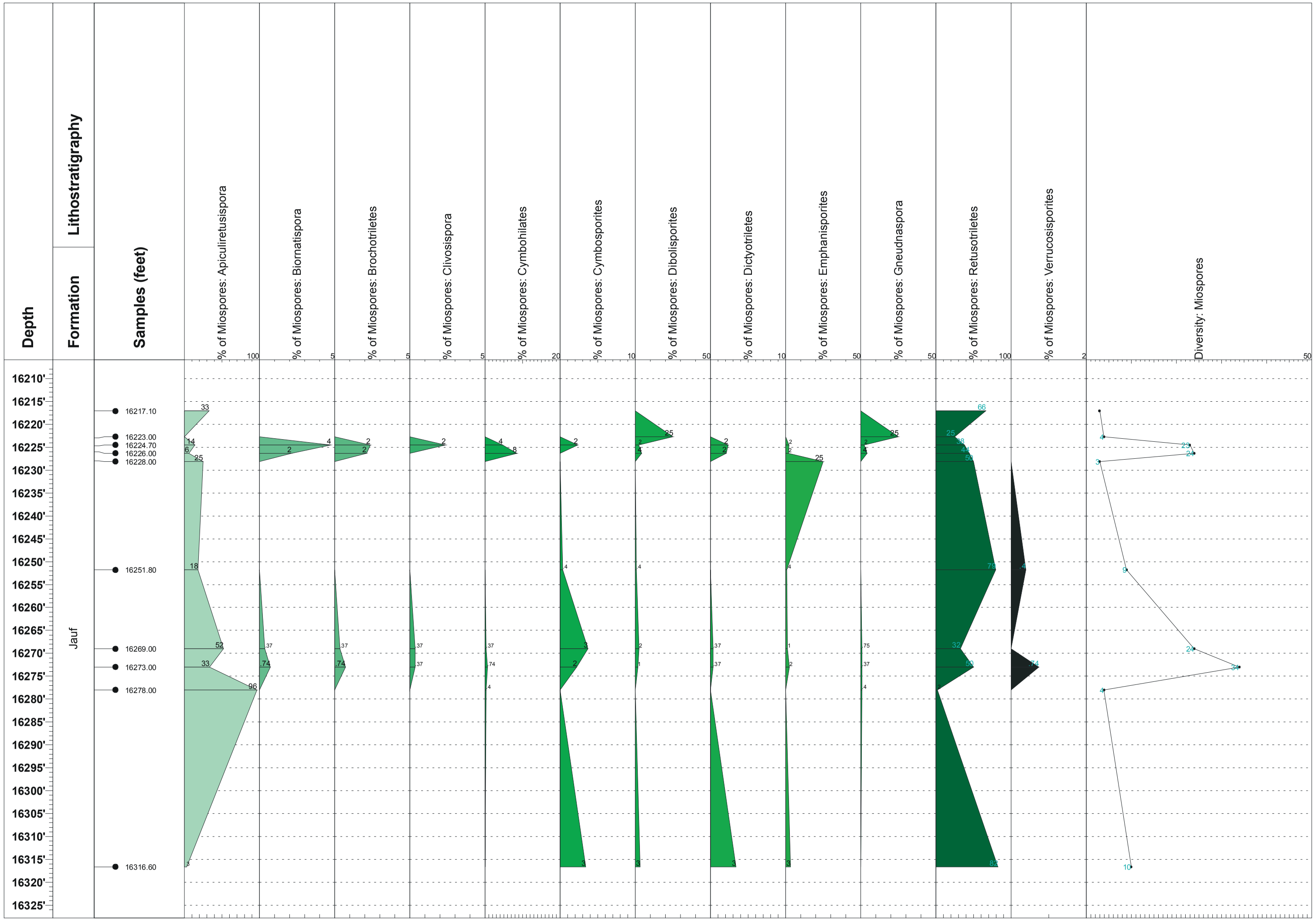

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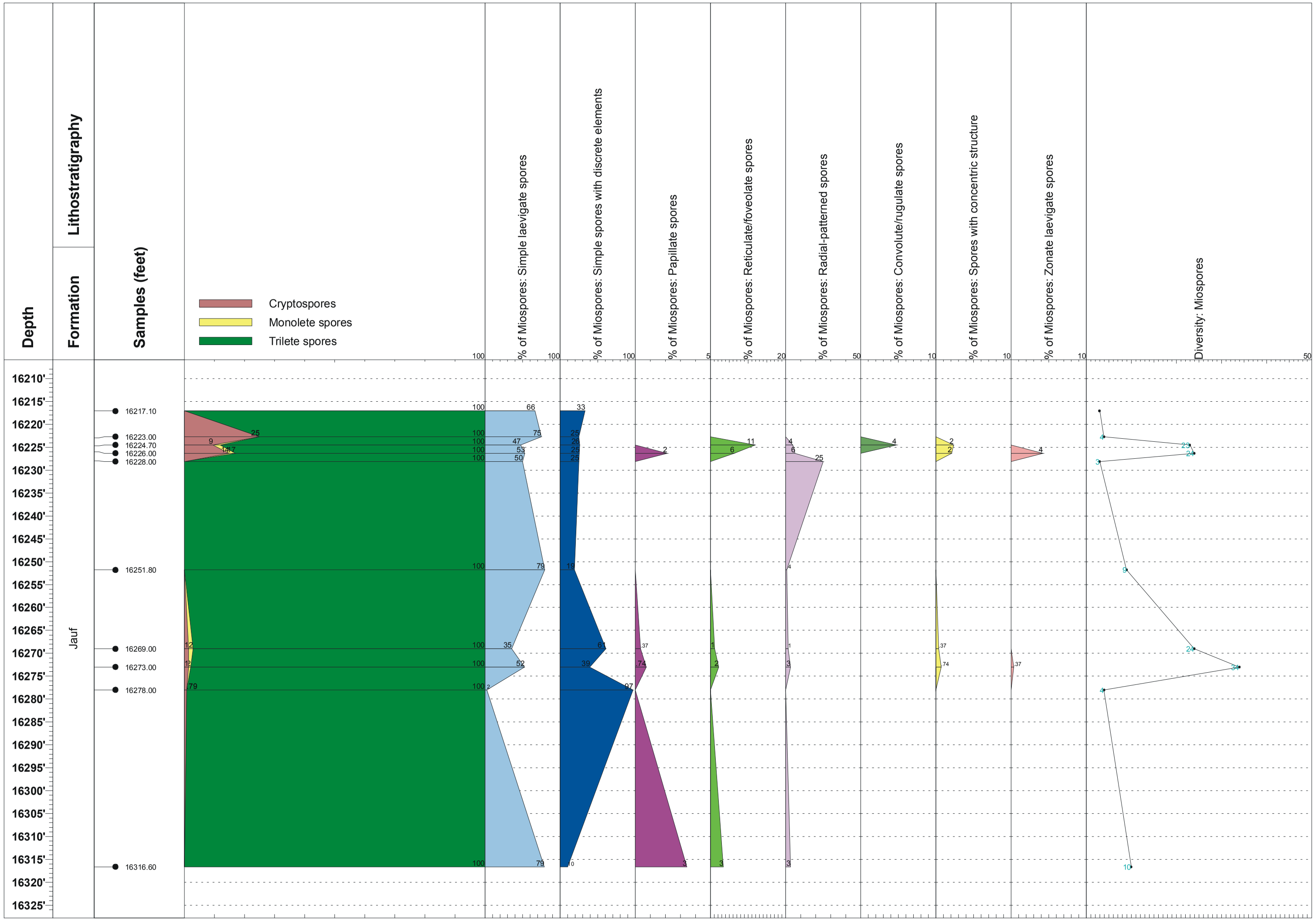

Fig. 2.47. Relative abundance of the main different miospore morphological groups encountered in KHRM-2.

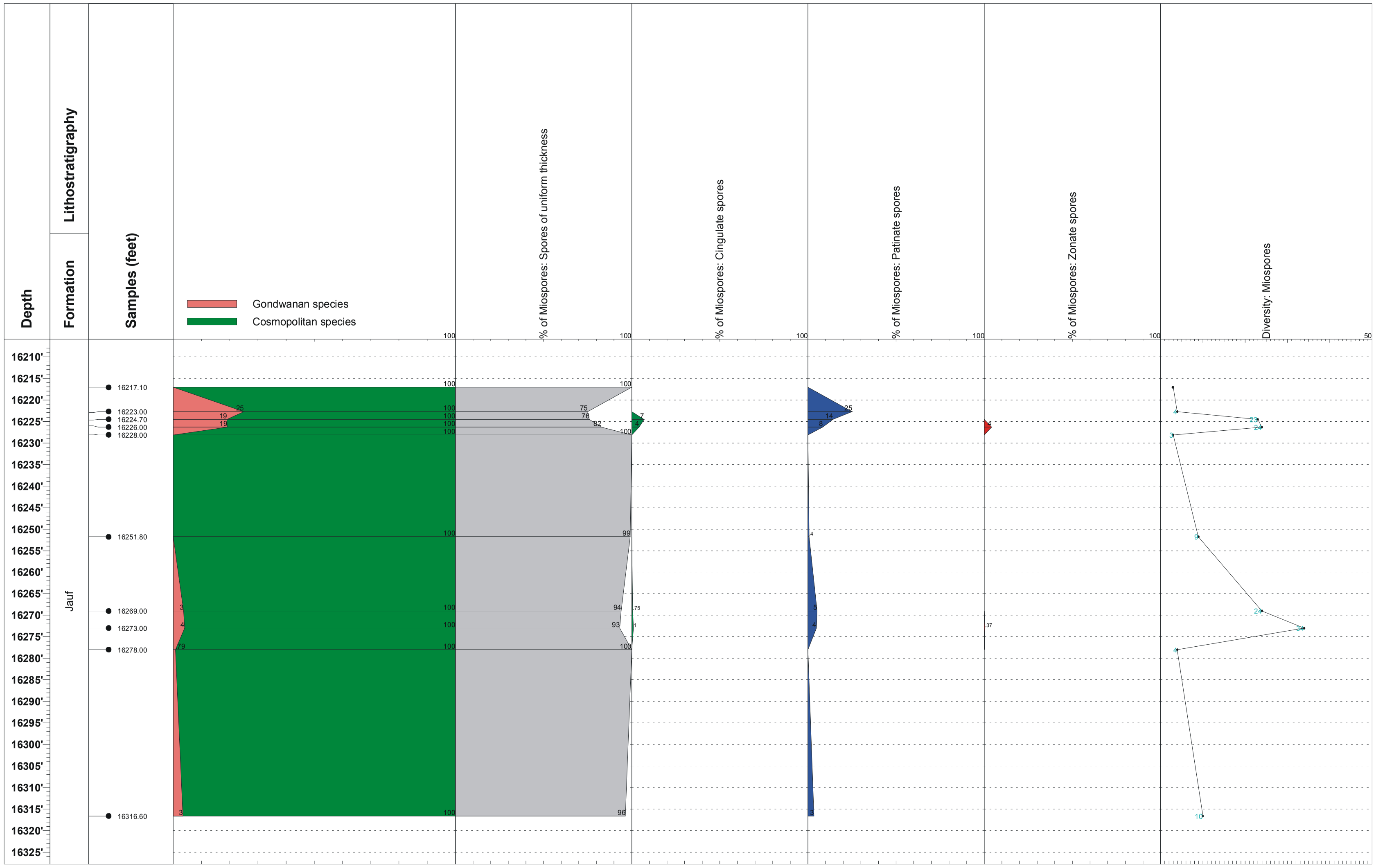

Fig. 2.48. Relative abundance of the miospore groups according to their palaeogeographic affinity in well KHRM-2 on the left and relative abundance of the different miospore structure groups.

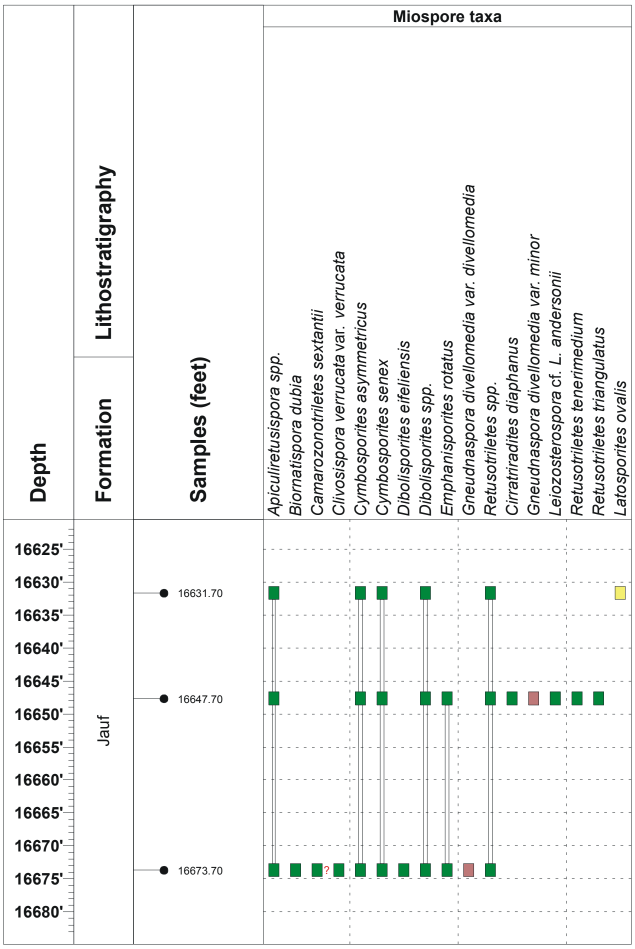

Fig. 2.49. Stratigraphic ranges of miospores encountered in well NFLA-1.

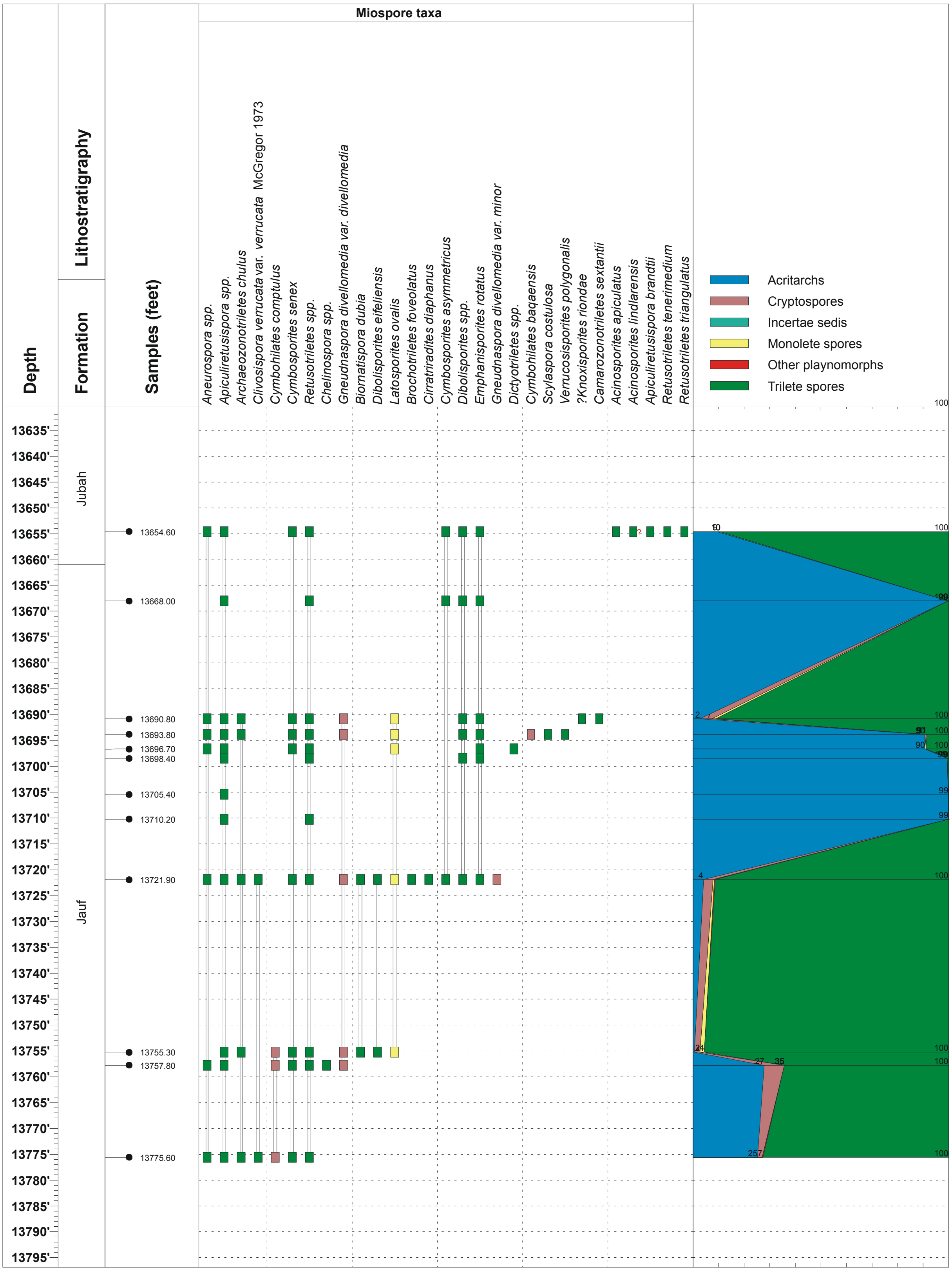

Fig. 2.50. Stratigraphic ranges of miospores encountered in well SDGM-462.

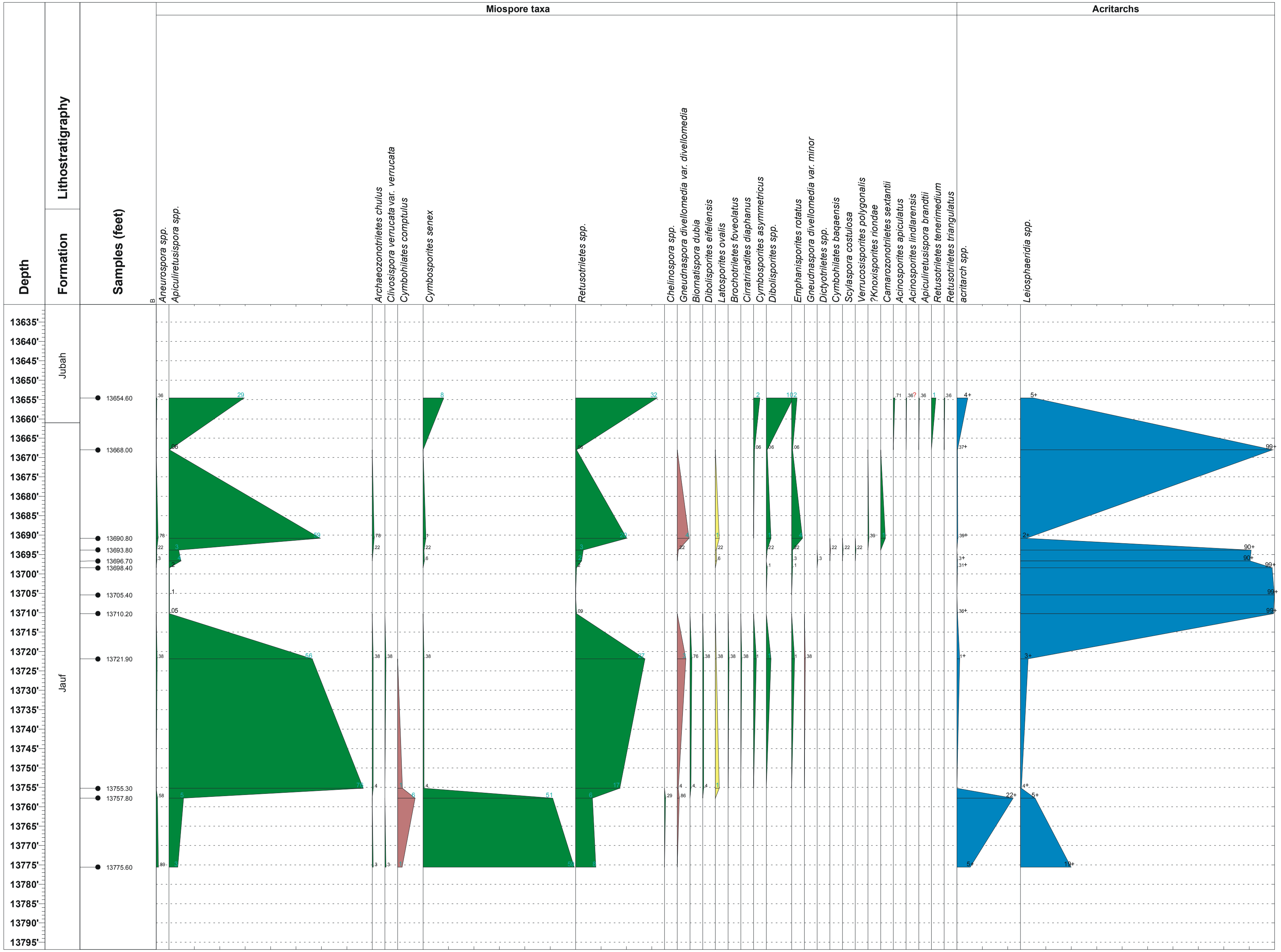

Fig. 2.51. Relative abundance of each individual taxon encountered in well SDGM-462.

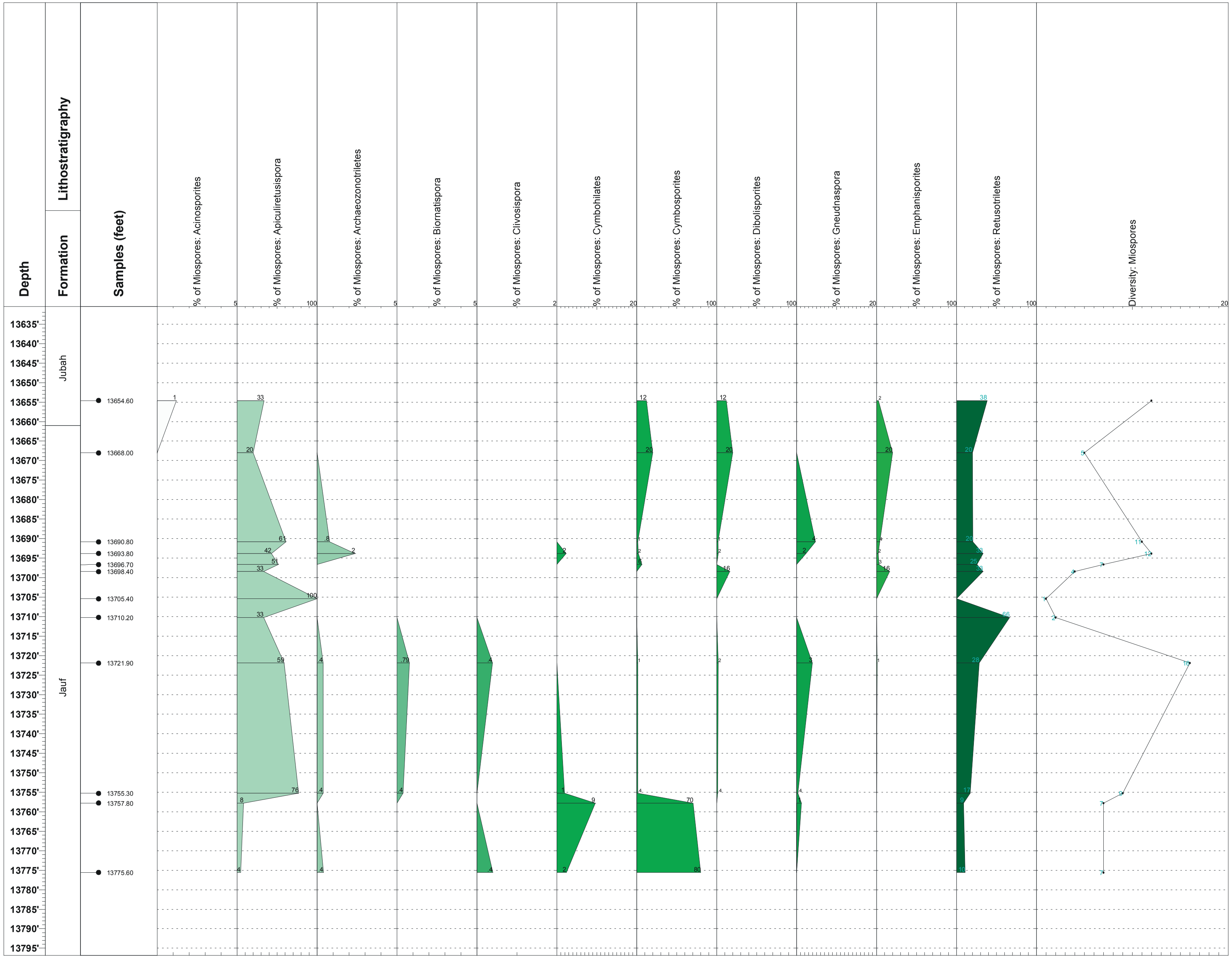

Fig. 2.52. Relative abundance of the main miospore genera encountered in well SDGM-462.

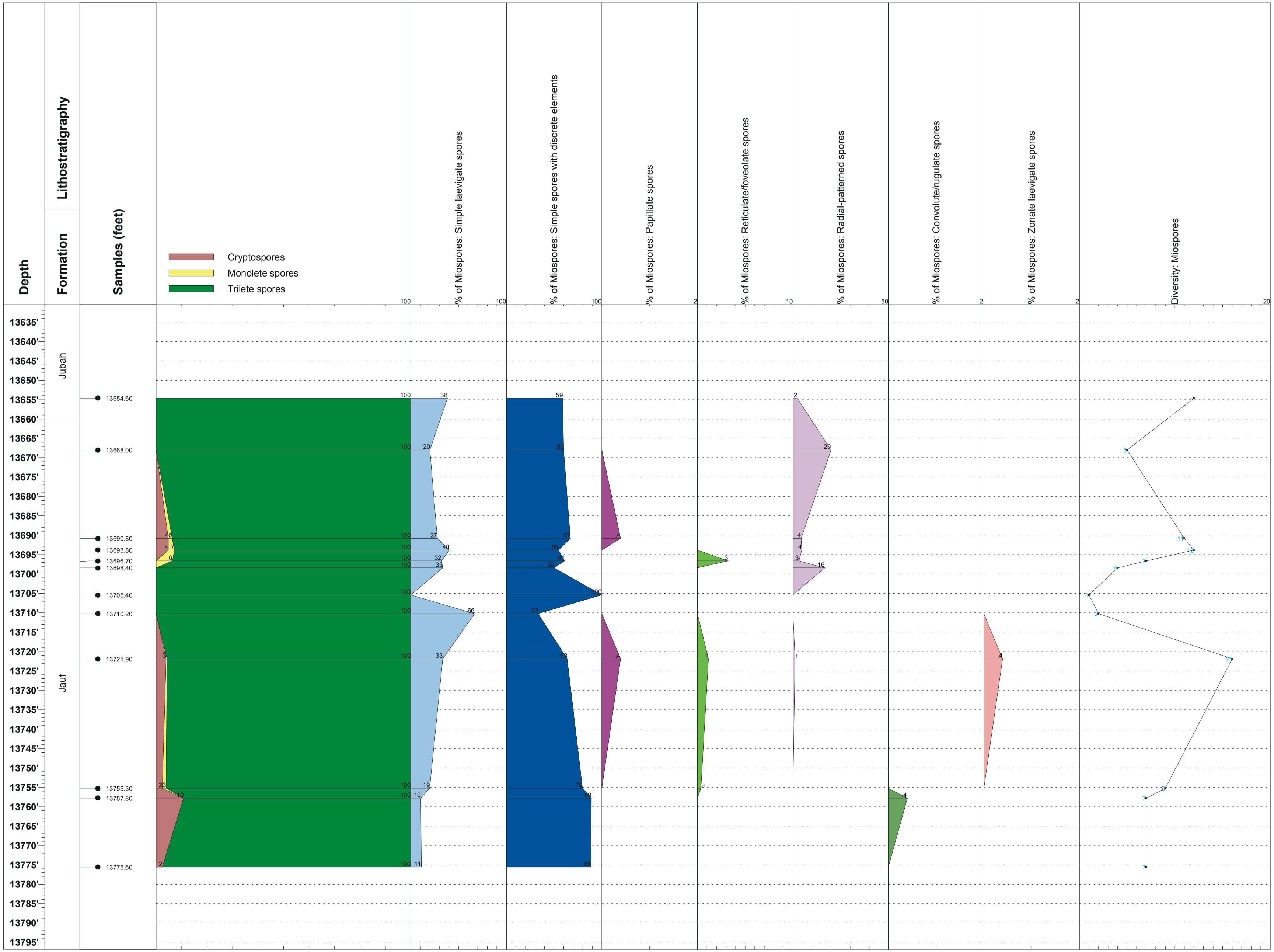

Fig. 2.53. Relative abundance of the main different miospore morphological groups encountered in well SDGM-462.

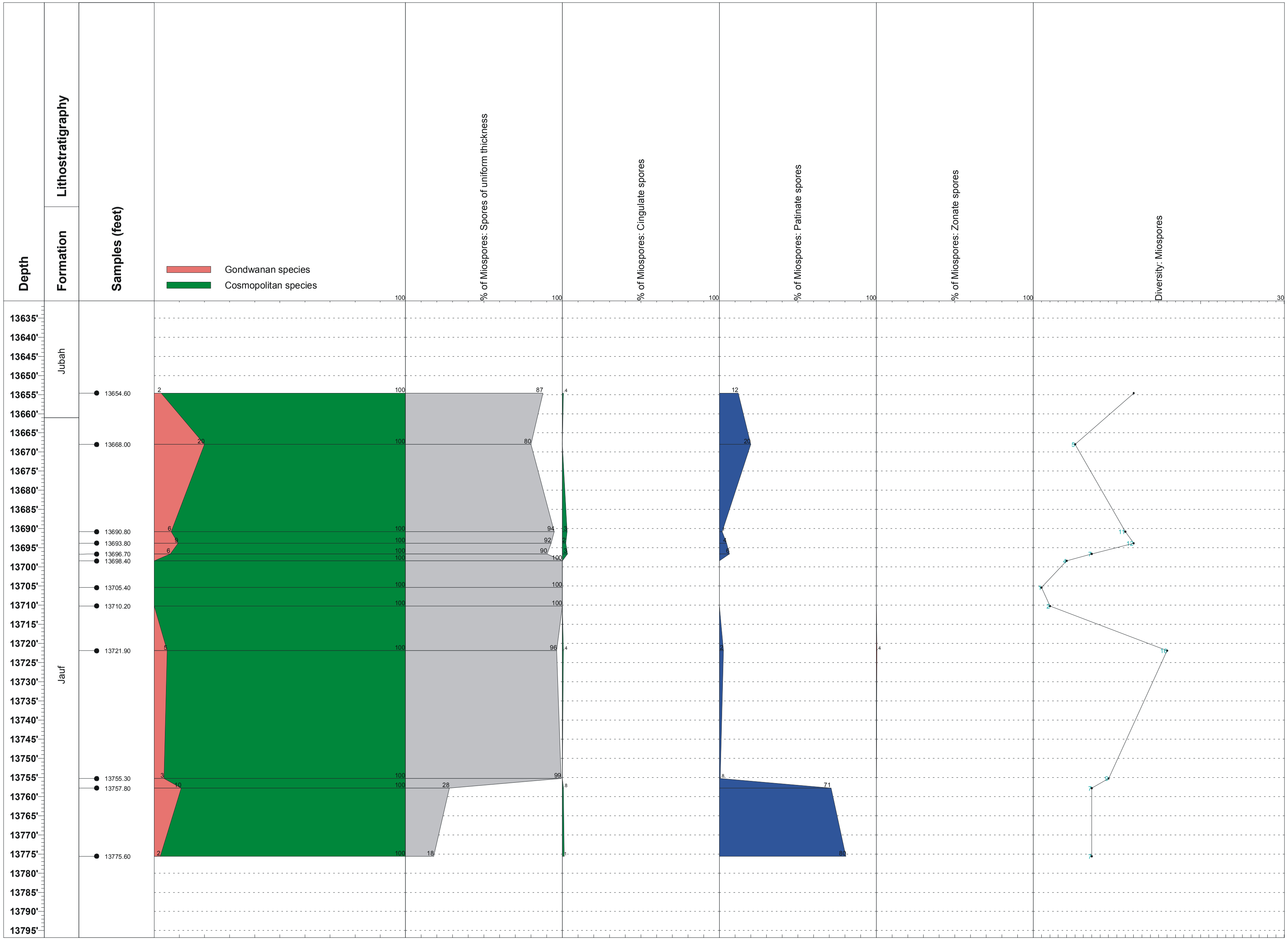

Fig. 2.54. Relative abundance of the miospore groups according to their palaeogeographic affinity in well SDGM-462 on the left and relative abundance of the different miospore structure groups.

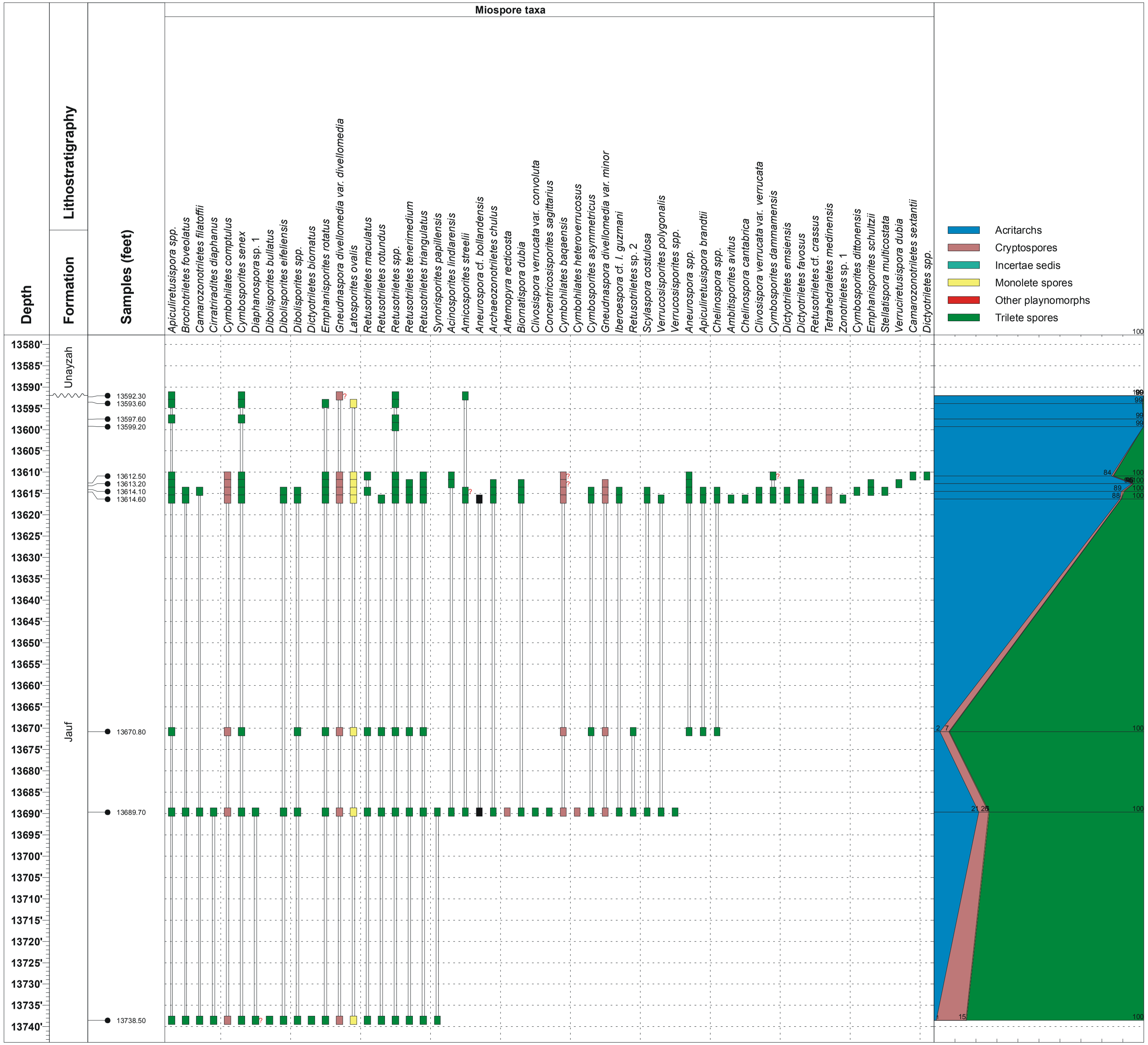

Fig. 2.55. Stratigraphic ranges of miospores encountered in well UTMN-1830.

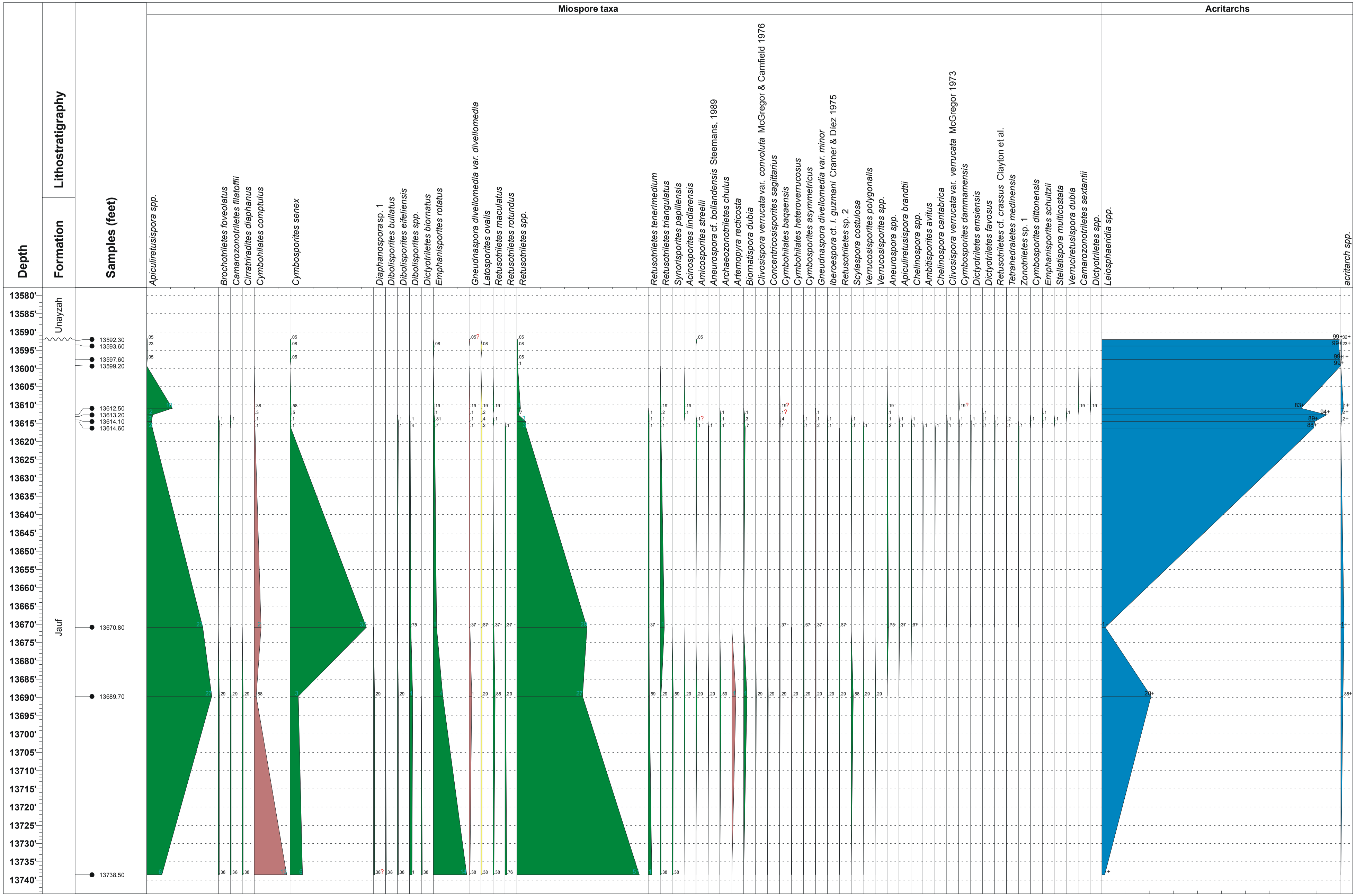

Fig. 2.56. Relative abundance of each individual taxon encountered in well UTMN-1830.

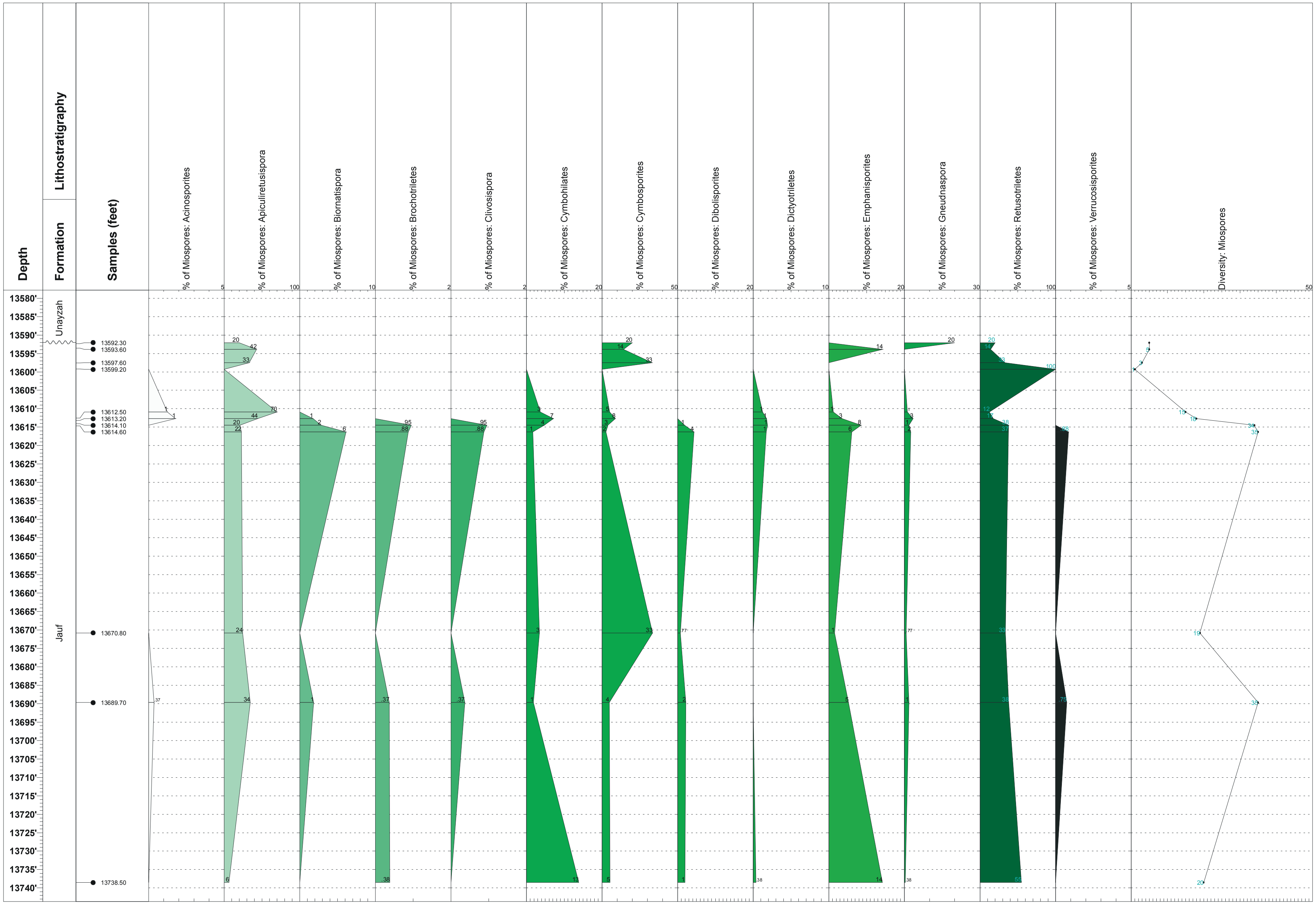

Fig. 2.57. Relative abundance of the main miospore genera encountered in well UTMN-1830.

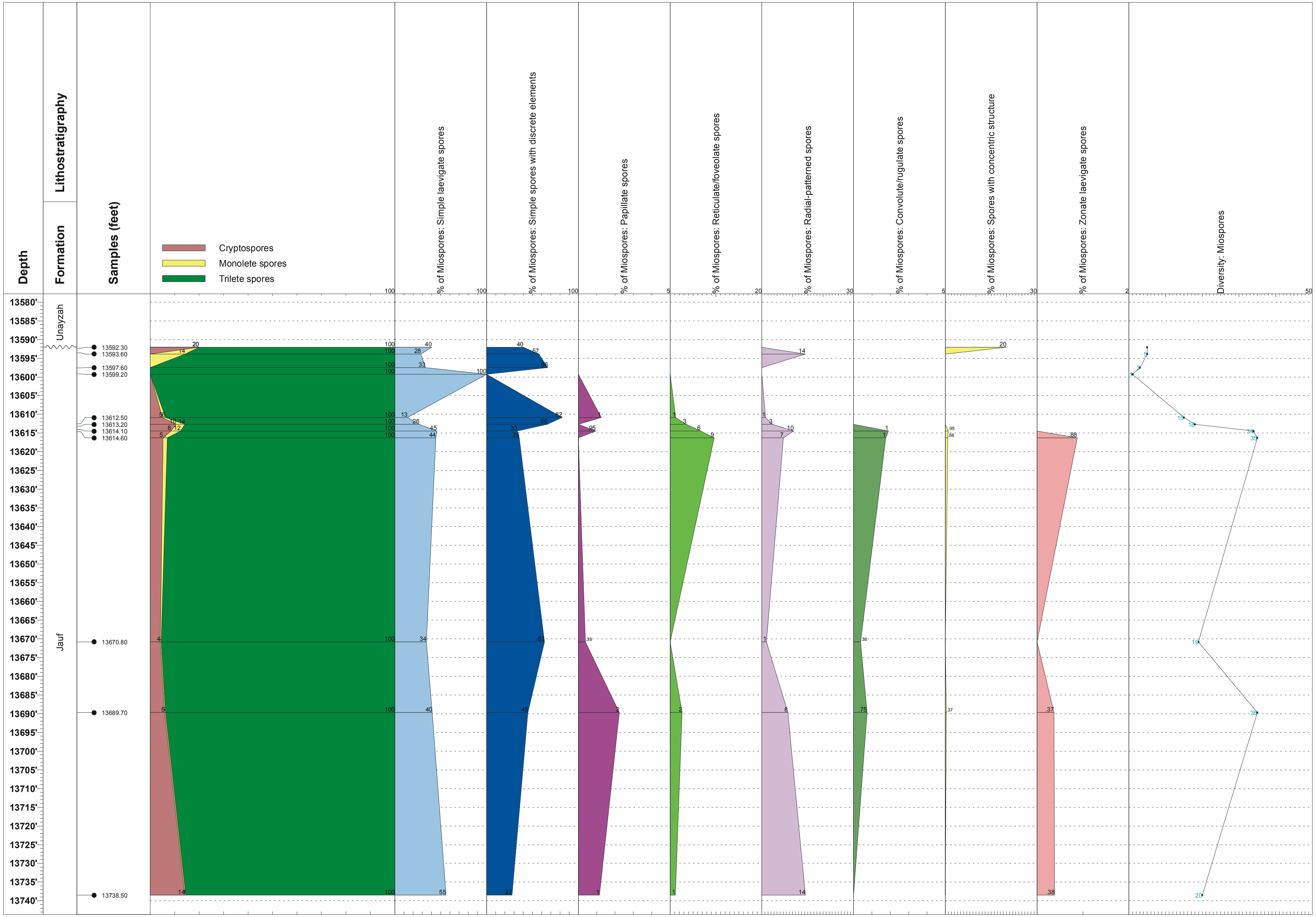

Fig. 2.58. Relative abundance of the main different miospore morphological groups encountered in well UTMN-1830.

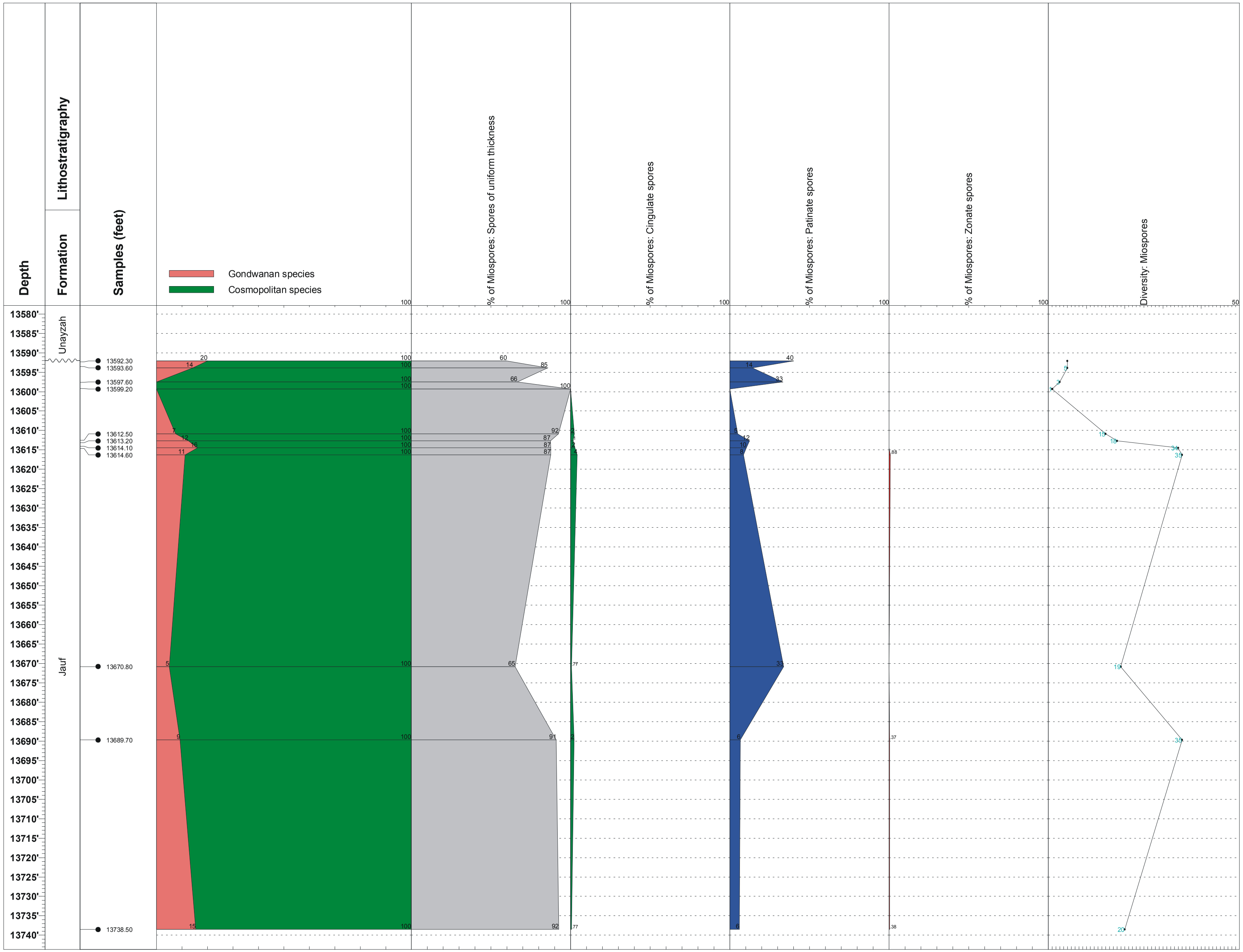

Fig. 2.59. Relative abundance of the miospore groups according to their palaeogeographic affinity in well UTMN-1830 on the left and relative abundance of the different miospore structure groups.

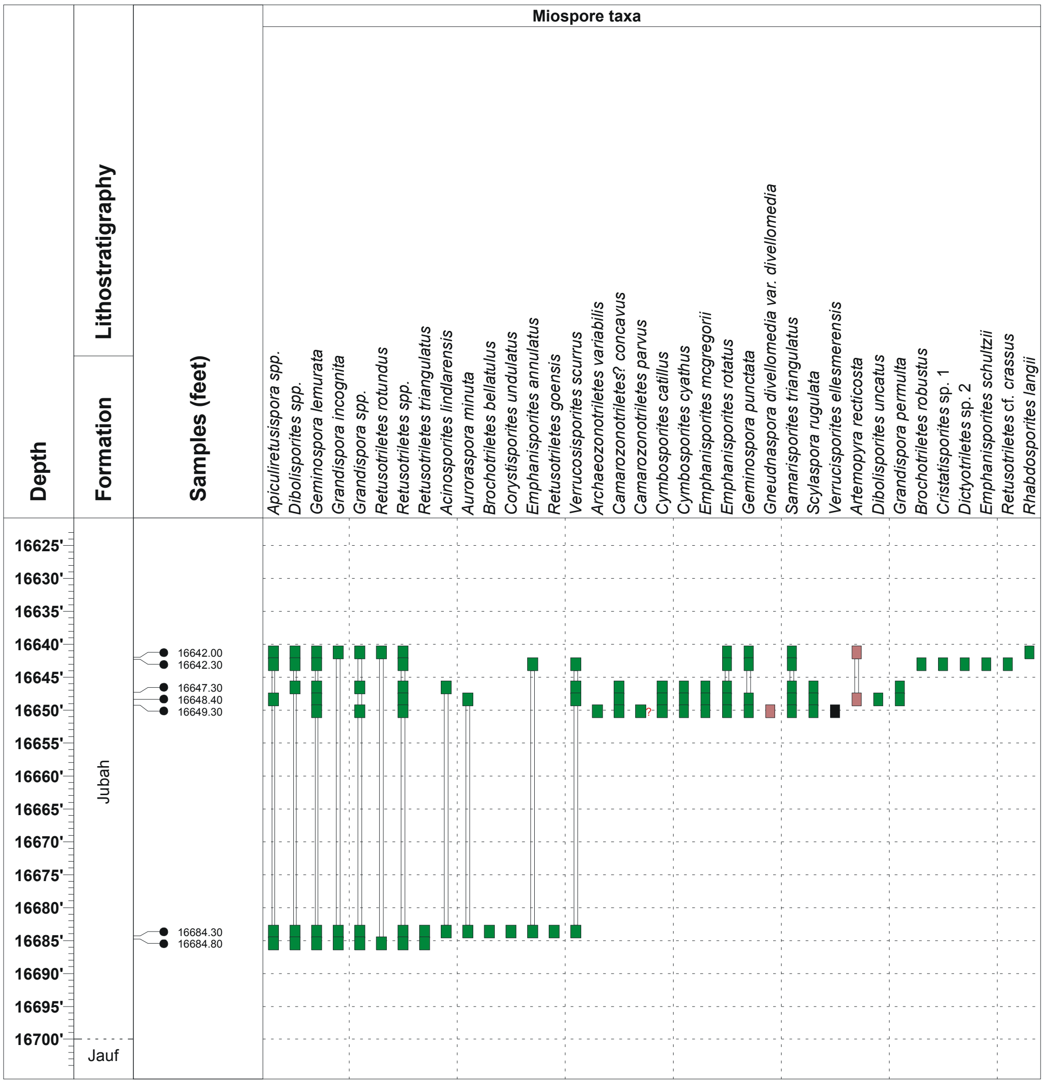

Fig. 2.60. Stratigraphic ranges of miospores encountered in well YBRN-1.

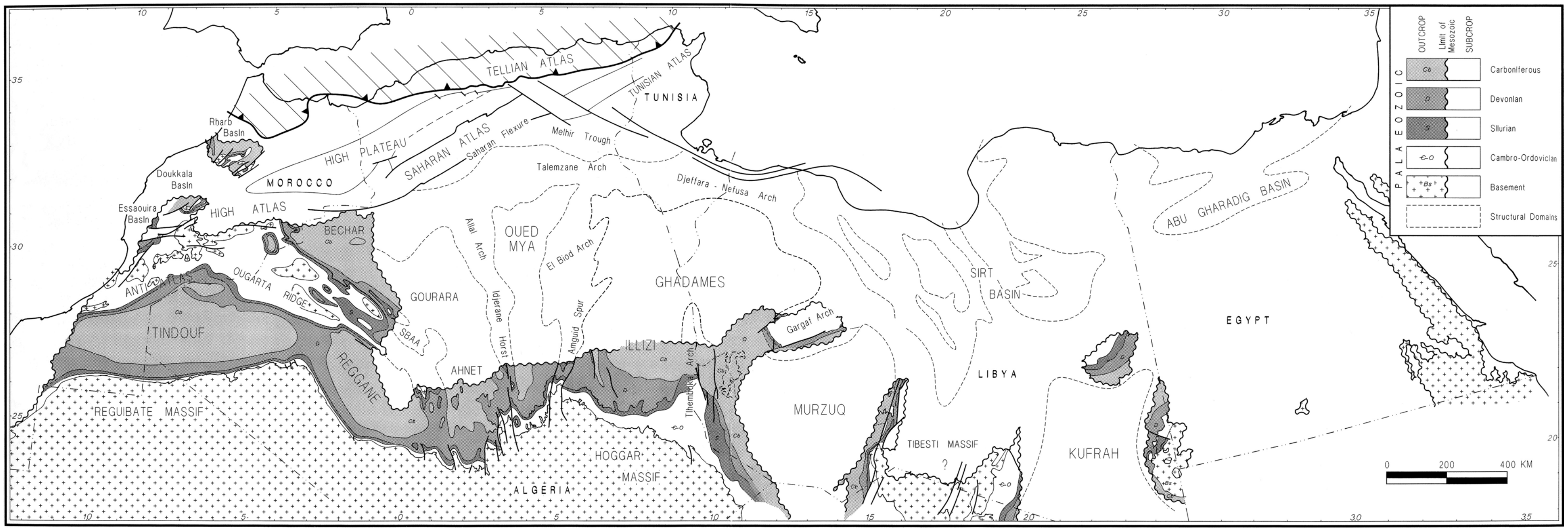

Fig. 3.1. Regional structural framework of North Africa, highlighting the main sedimentary basins. These include the northeast-southwest aligned Atlas fault system extending into the Djeffara fault trend to the east. Basement and Palaeozoic outcrops in the southern part of the region are shown by various shading (modified after Boote et al., 1998).

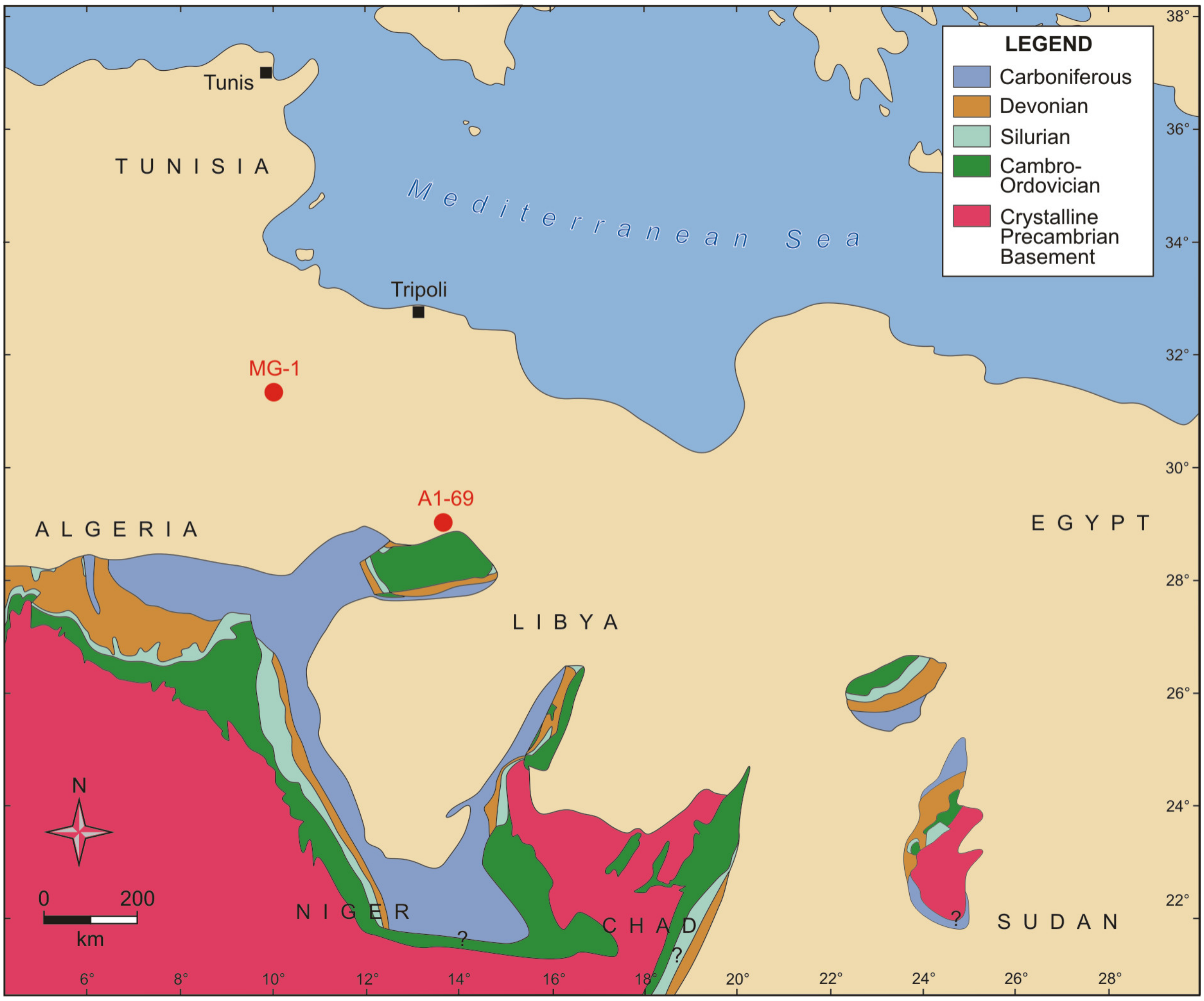

Fig. 3.2. Palaeozoic outcrops in Northern Africa (modified after Boote et al., 1998 and Massa, 1988).

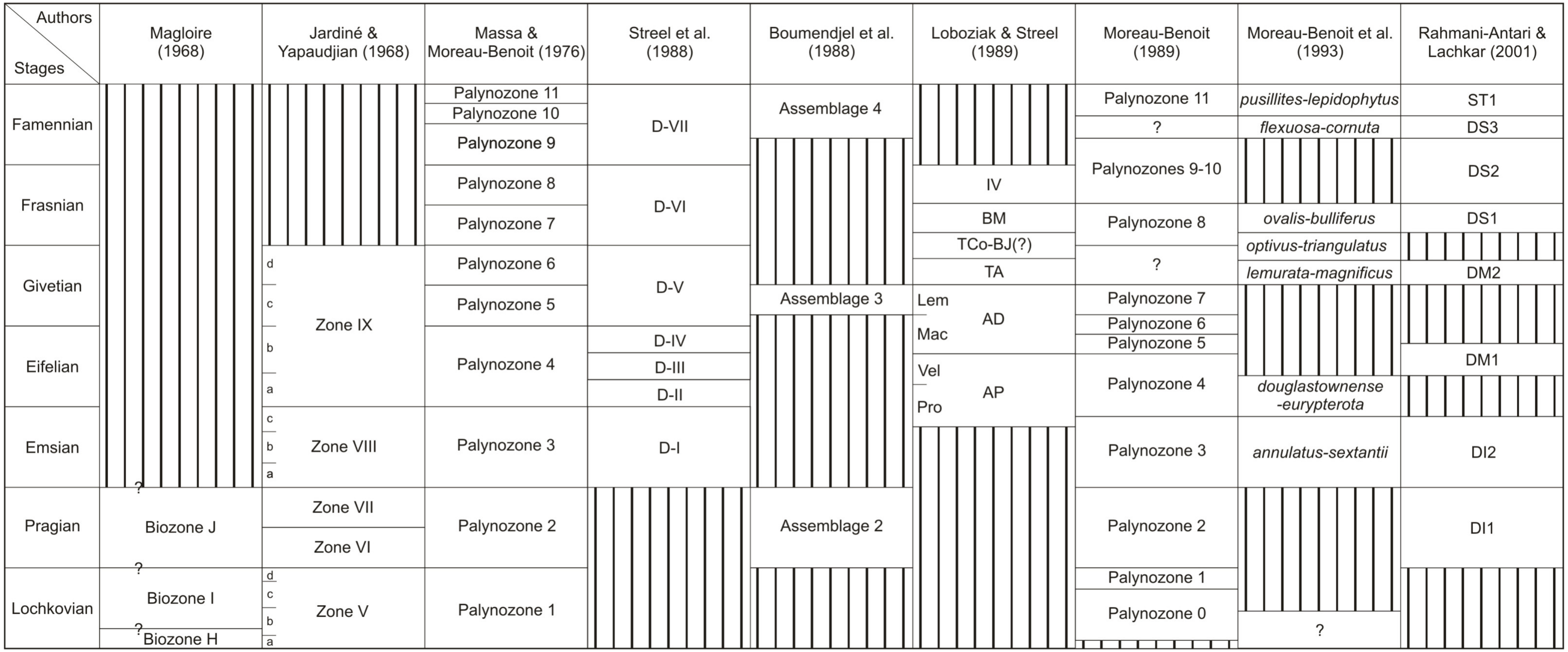

Fig. 3.3. Chart comparing biozonation from the main studies on Devonian from North Africa. Loboziak & Streel (1989) used biozonation of Streel et al. (1987) and Moreau-Benoit et al. (1993) used biozonation of Richardson & McGregor (1986). Moreau-Benoit (1989) reinterpreted biozones defined previously in Massa & Moreau-Benoit (1976).

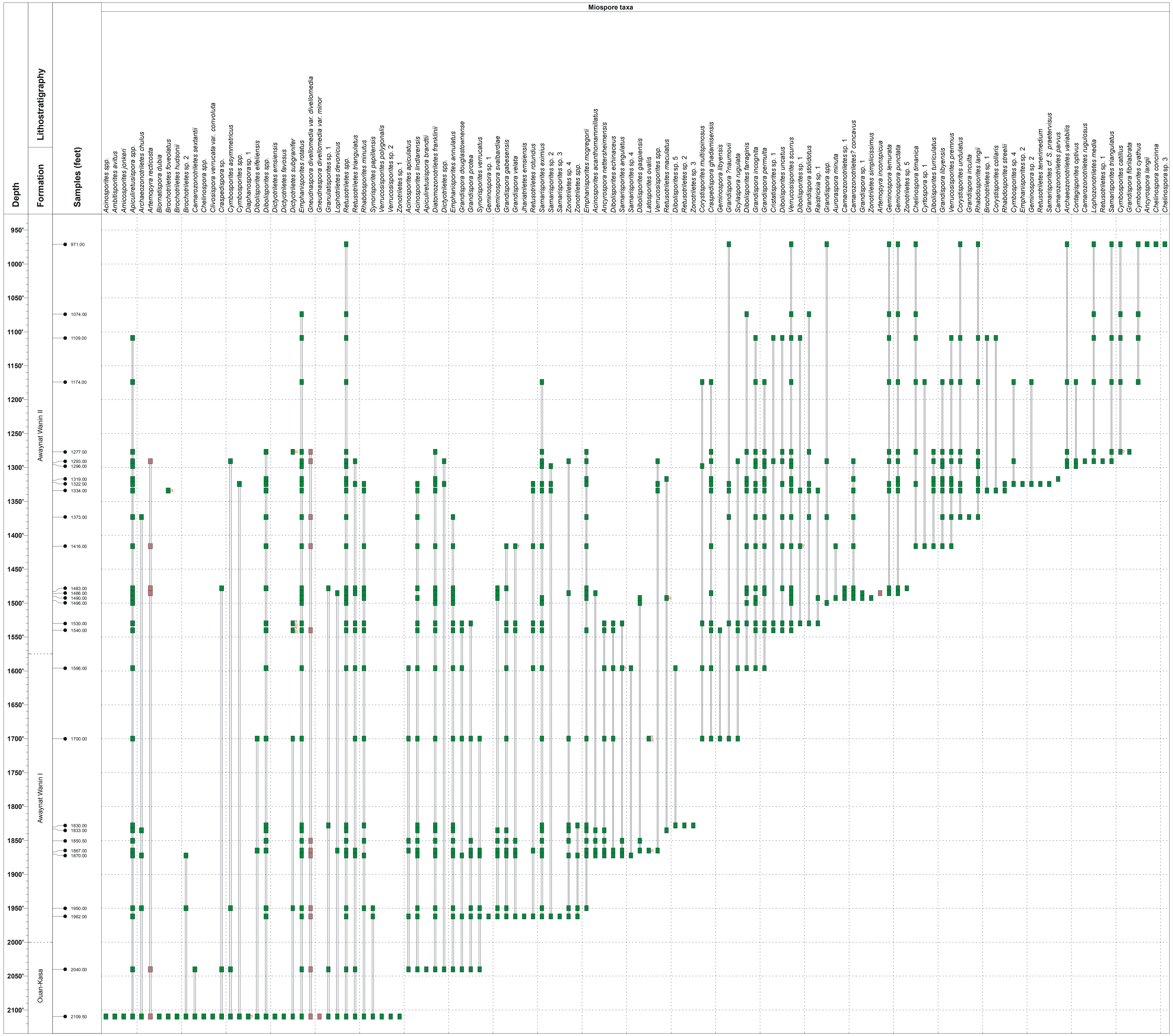

Fig. 3.4. Stratigraphic ranges of miospores encountered in borehole A1-69.

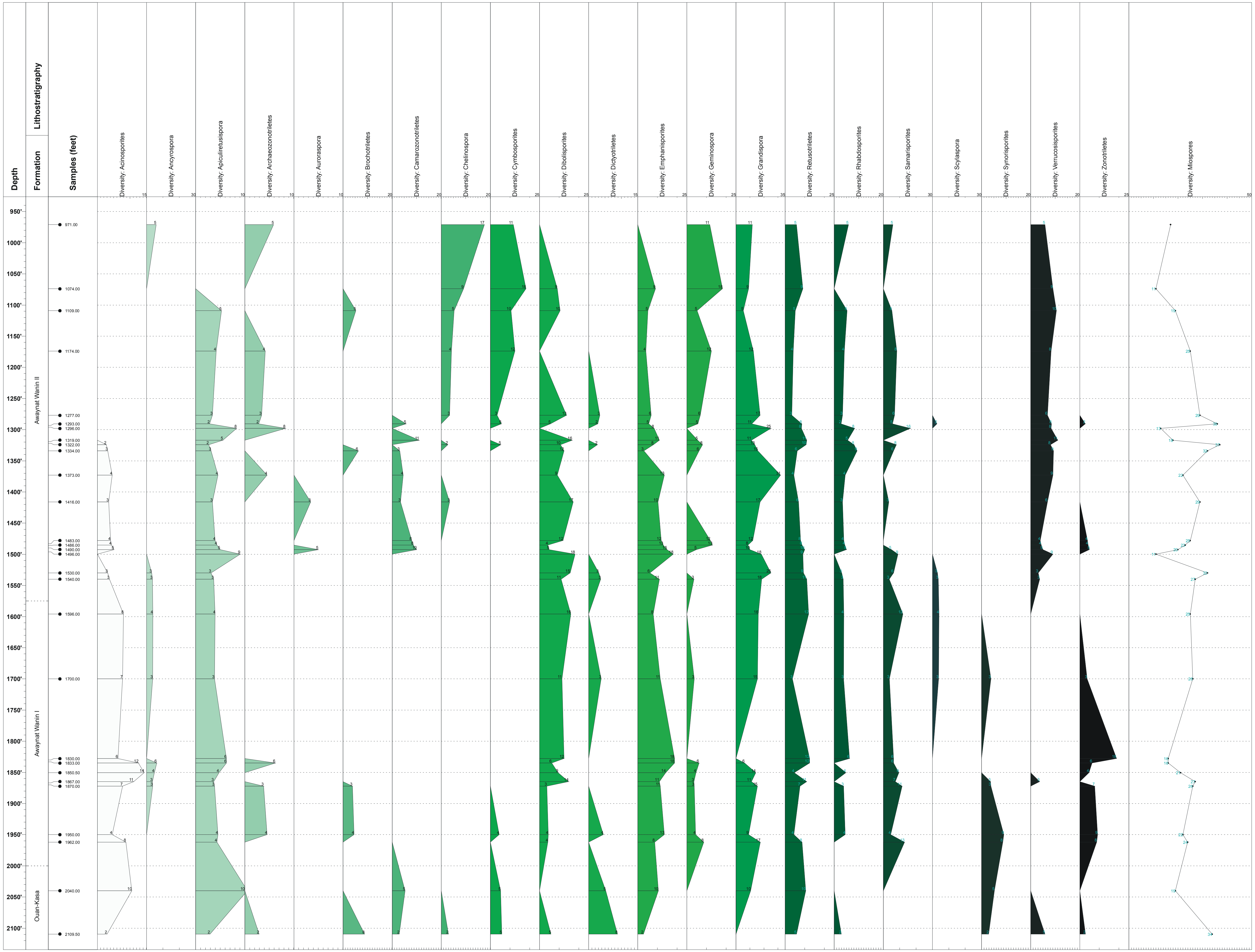

Fig. 3.5. Relative abundance of the main miospore genera encountered in borehole A1-69.

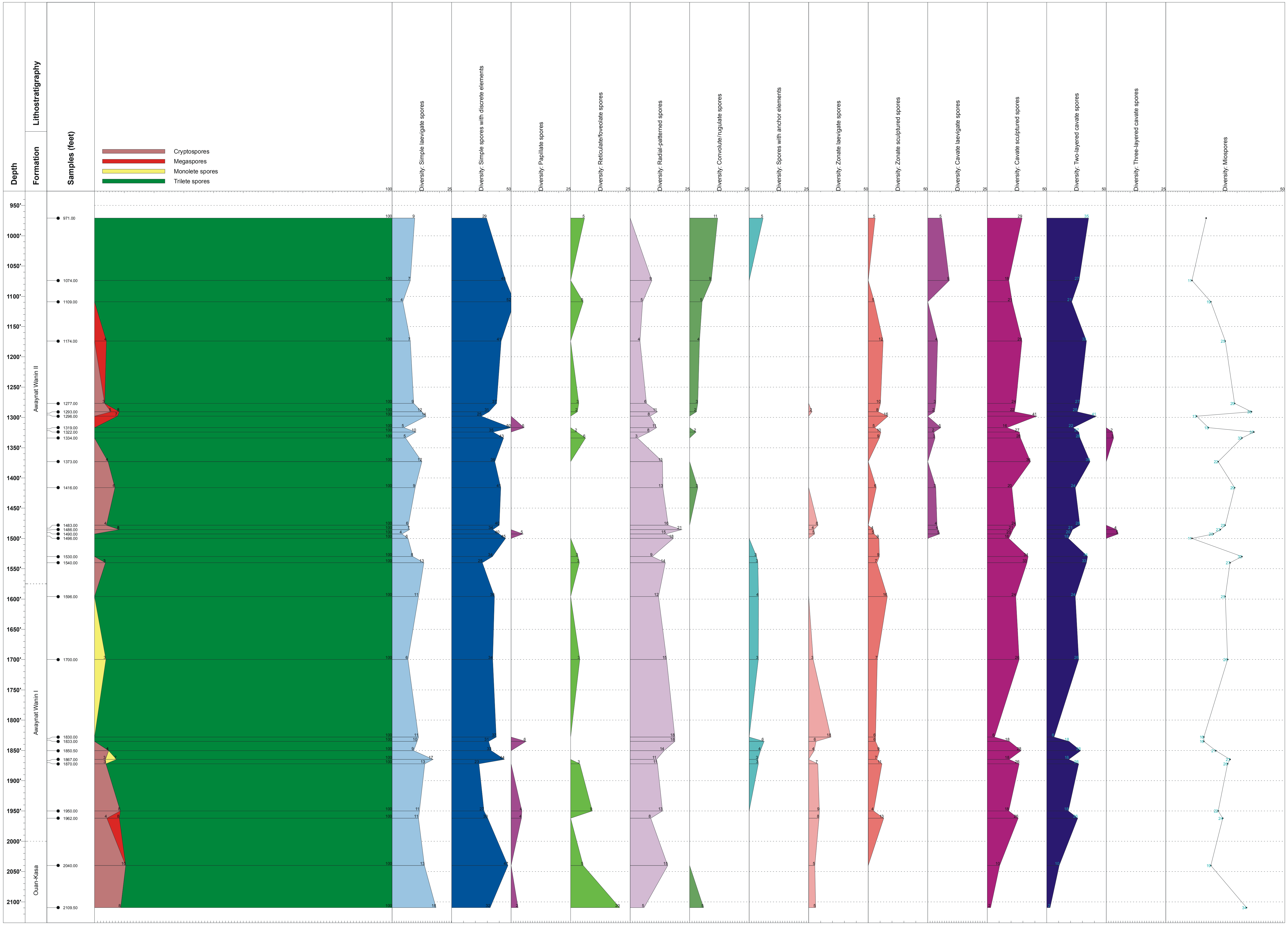

Fig. 3.6. Relative abundance of the main different miospore morphological groups encountered in borehole A1-69.

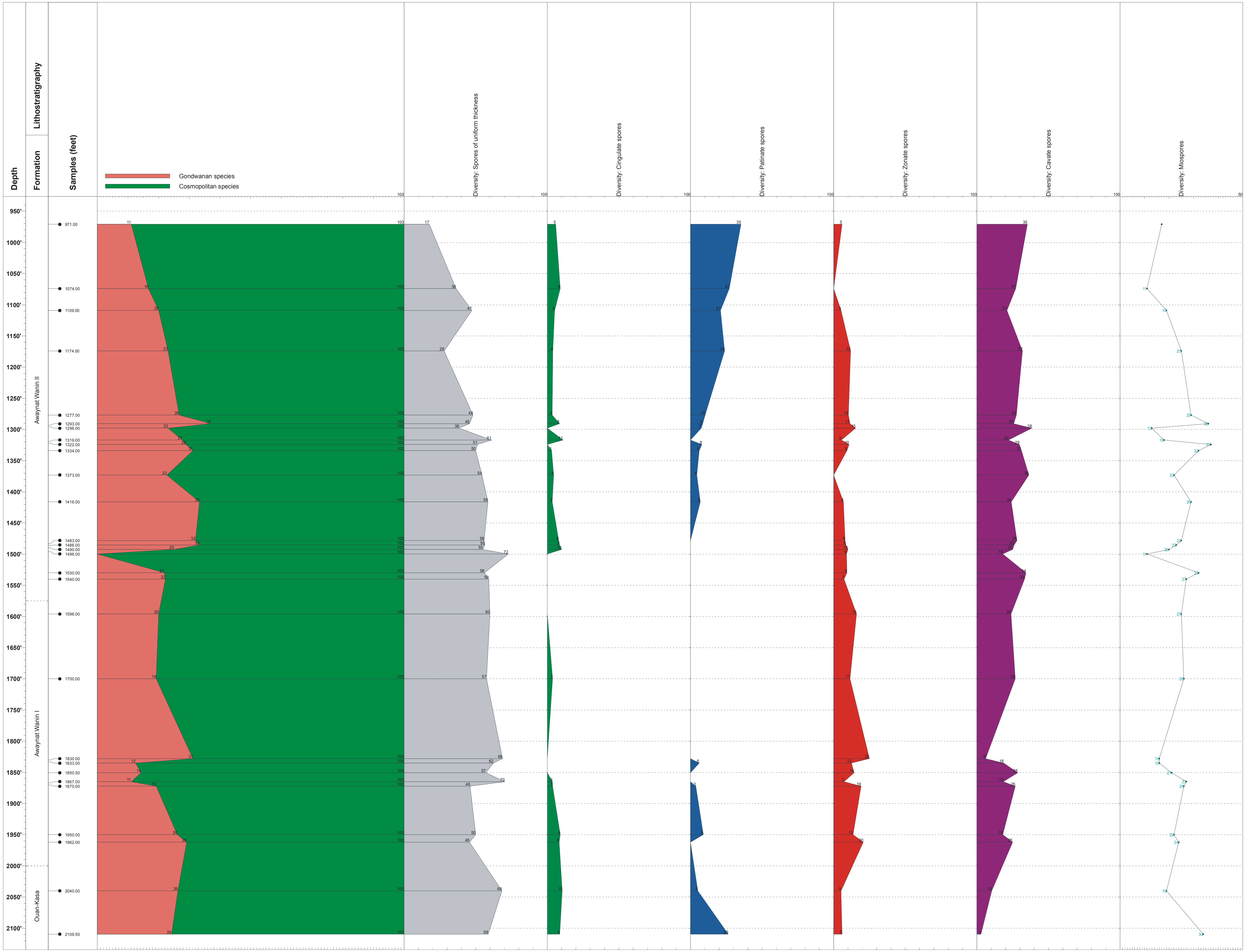

Fig. 3.7. Relative abundance of the miospore groups according to their palaeogeographic affinity in borehole A1-69 on the left and relative abundance of the different miospore structure groups.

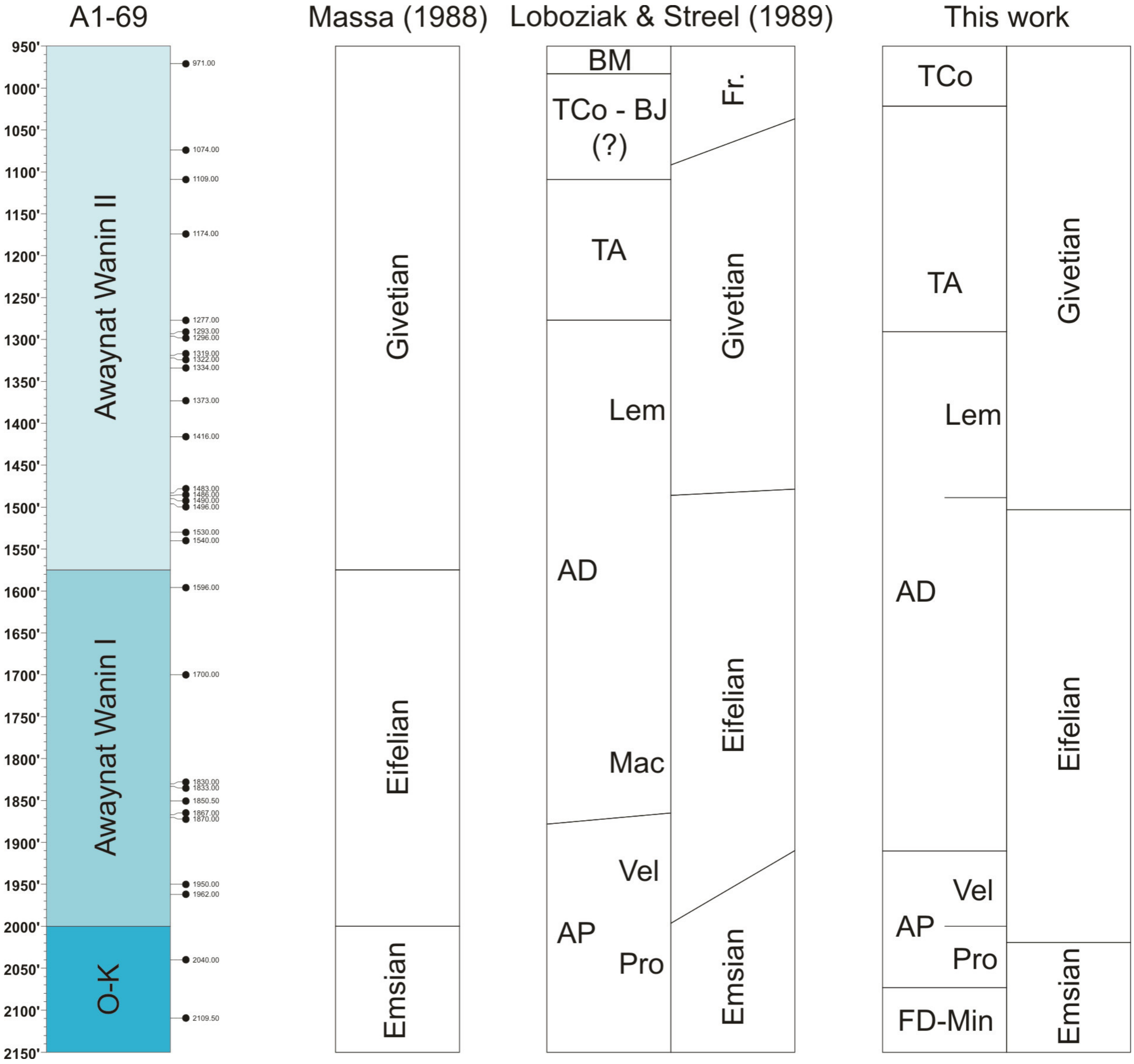

Fig. 3.8. Palynostratigraphic and chronostratigraphic charts for borehole A1-69.

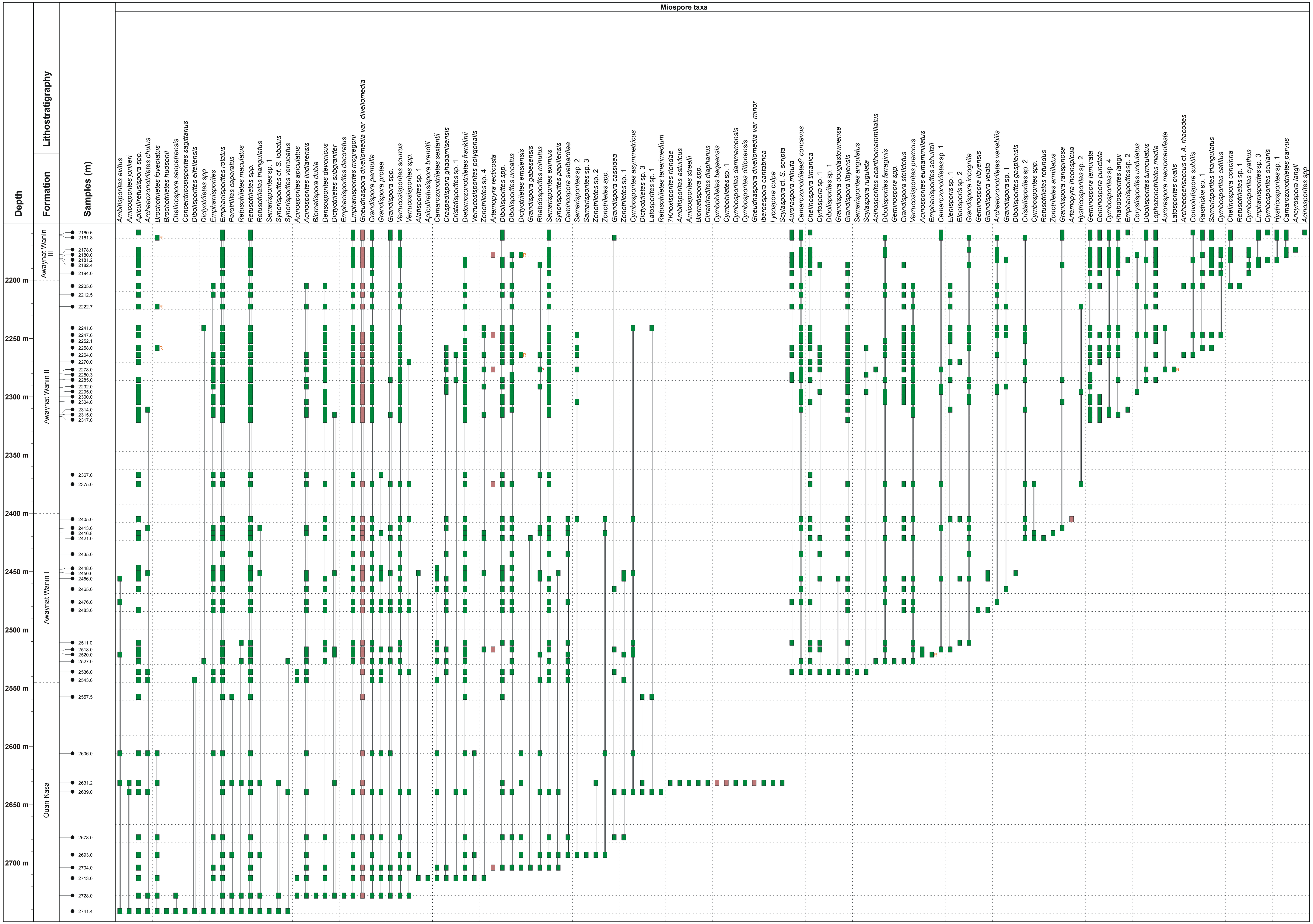

Fig. 3.9. Stratigraphic ranges of miospores encountered in borehole MG-1.

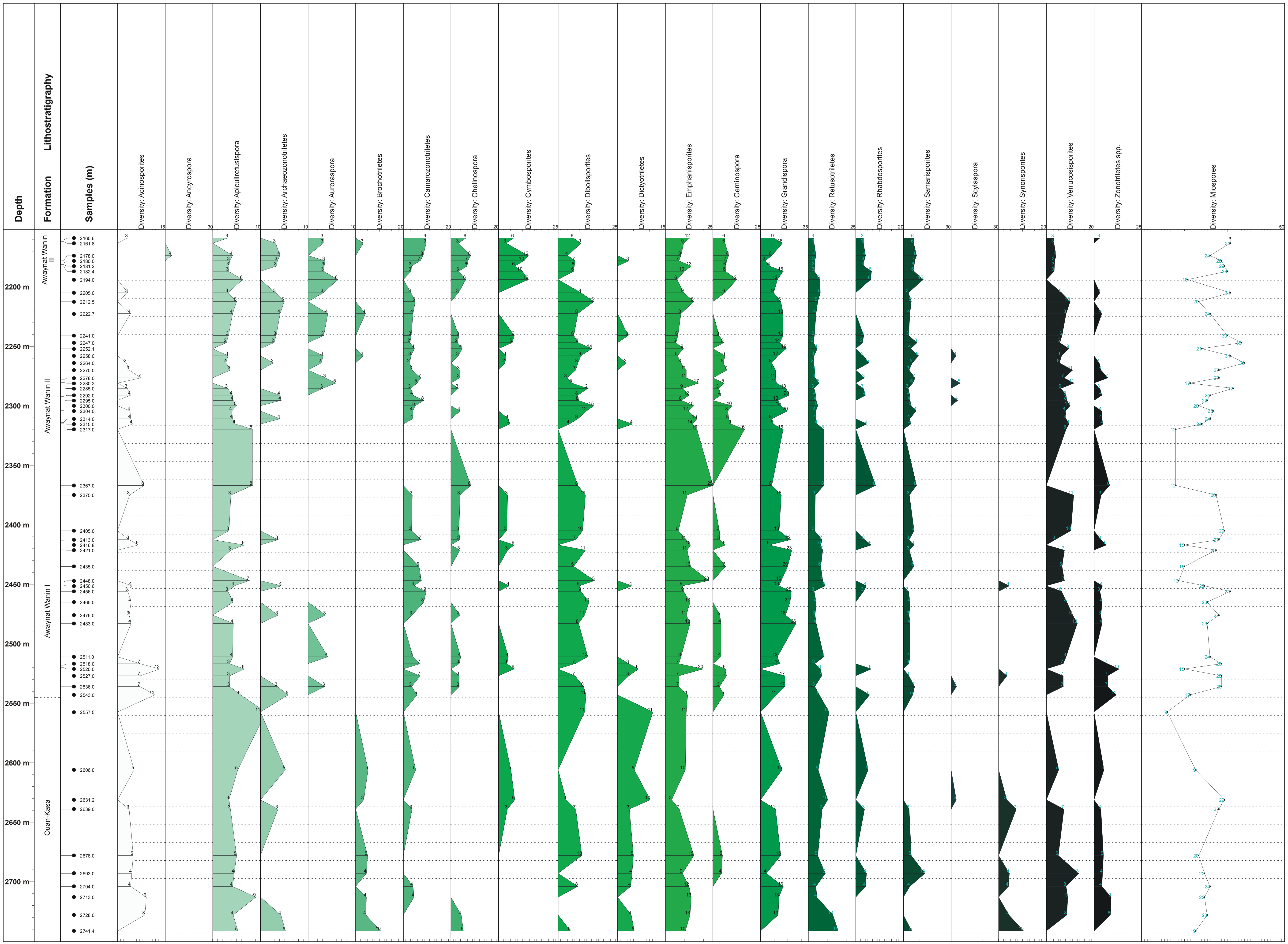

Fig. 3.10. Relative abundance of the main miospore genera encountered in borehole MG-1.

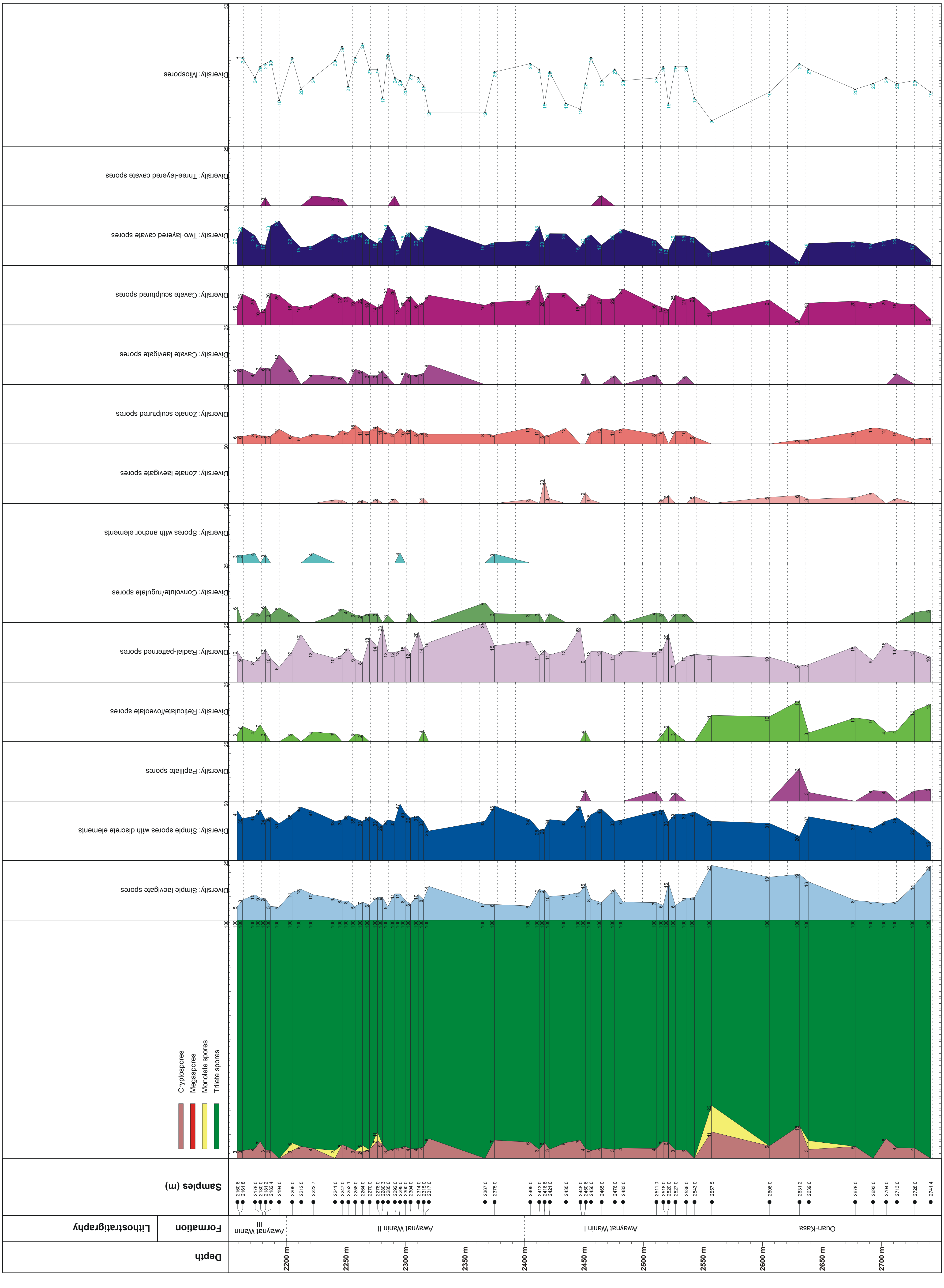

Fig. 3.11. Relative abundance of the main different miospore morphological groups encountered in borehole MG-1.

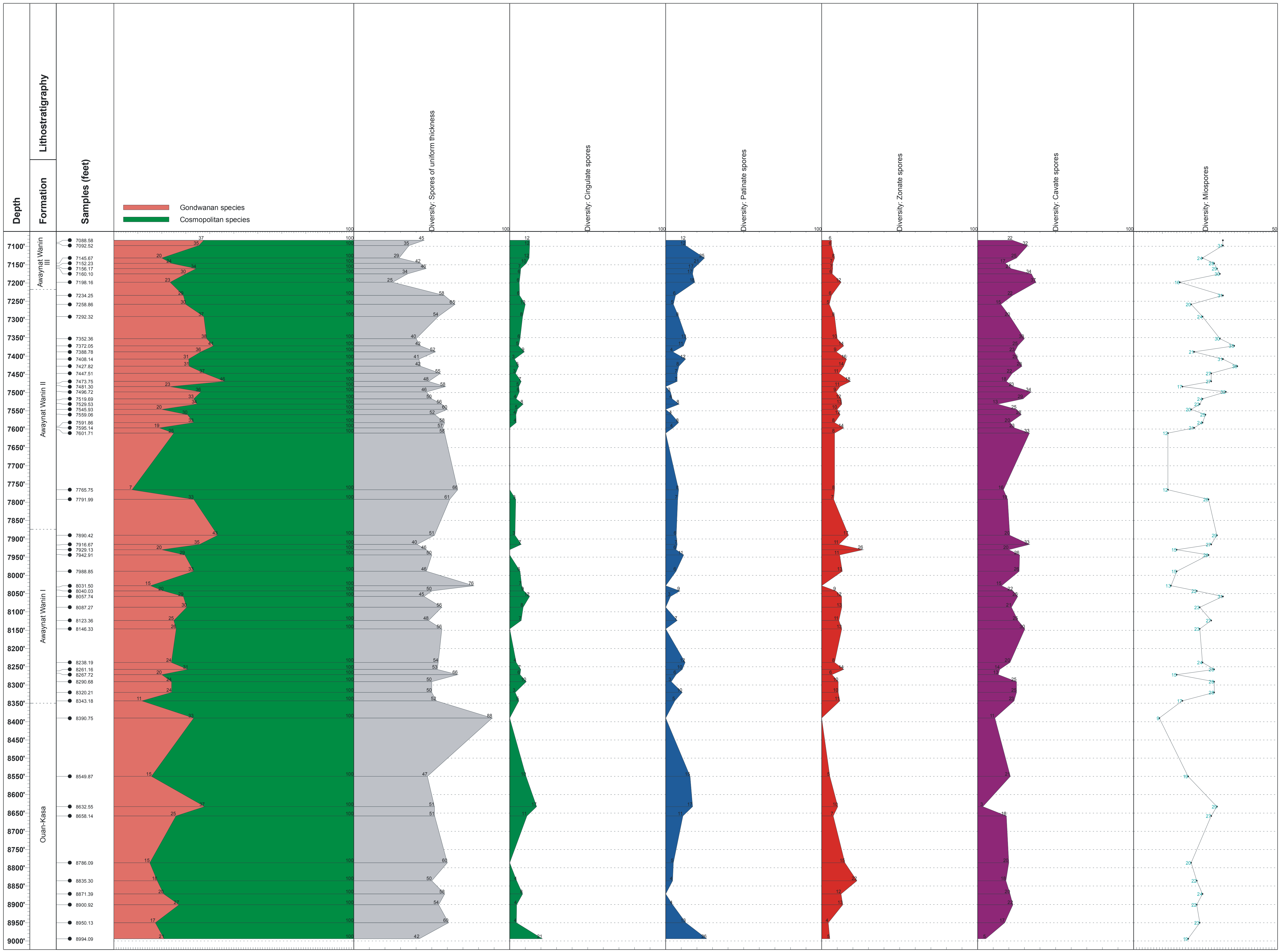

Fig. 3.12. Relative abundance of the miospore groups according to their palaeogeographic affinity in borehole MG-1 on the left and relative abundance of the different miospore structure groups.

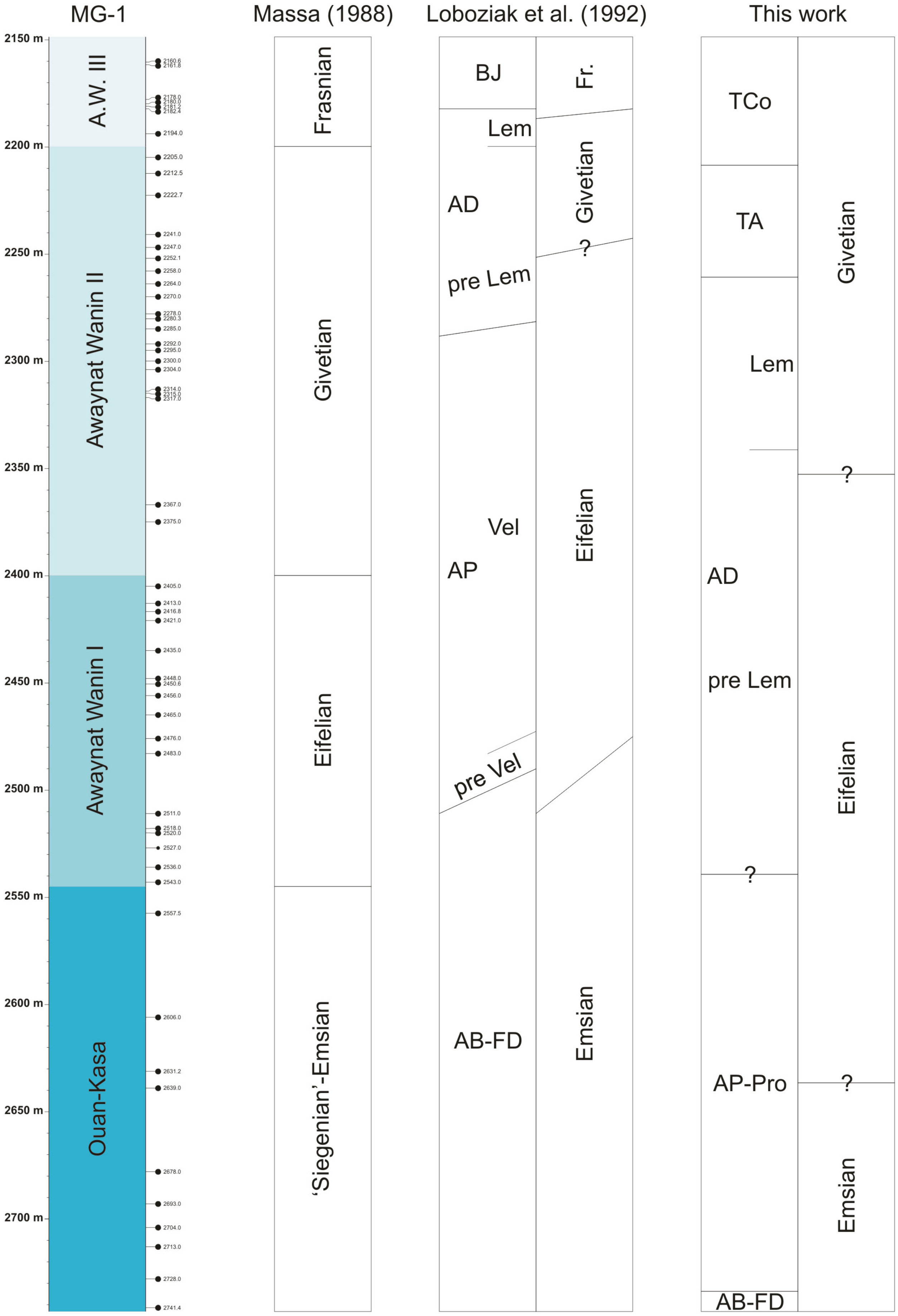

Fig. 3.13. Palynostratigraphic and chronostratigraphic charts for borehole MG-1.

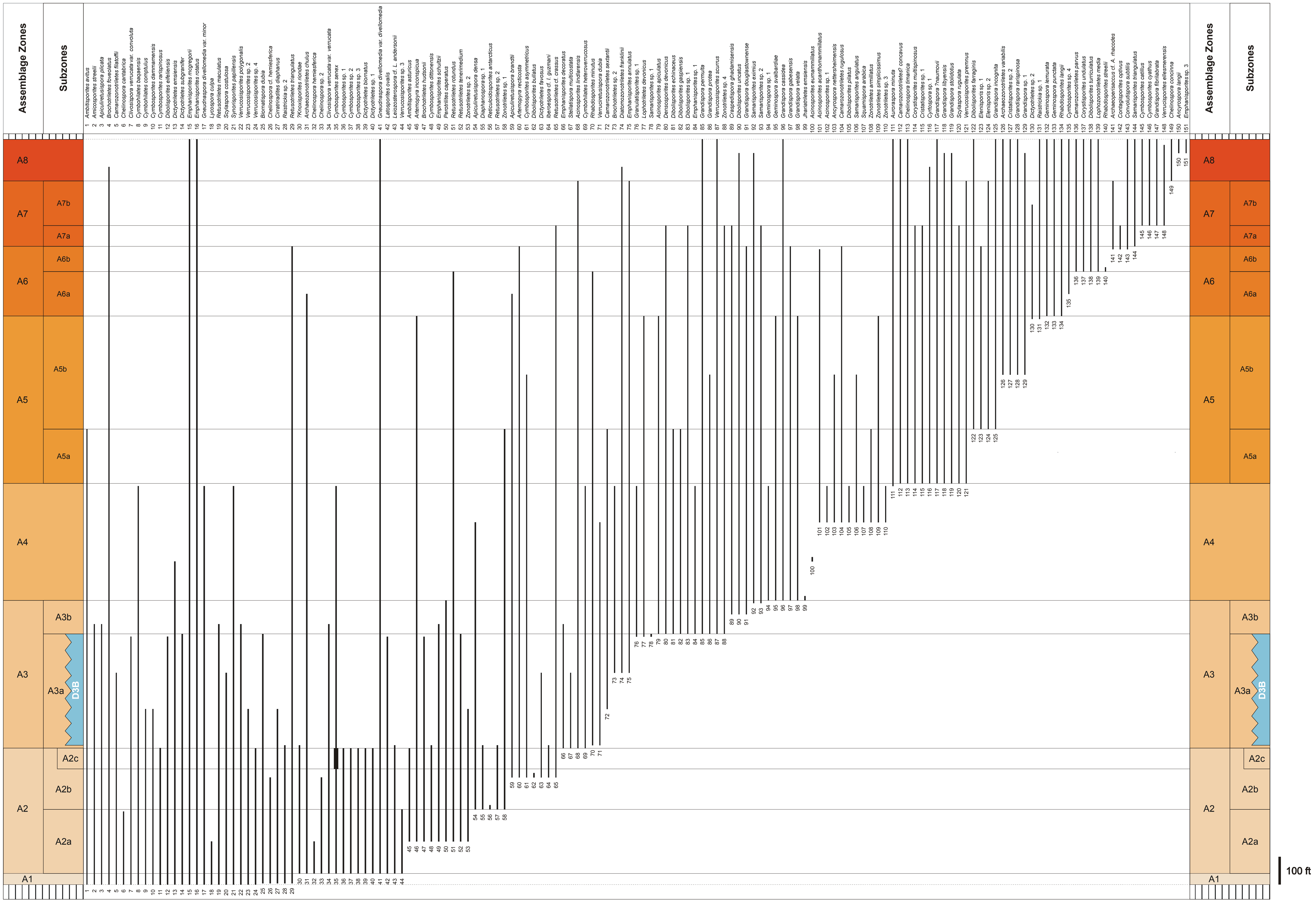

Fig. 4.1. Composite stratigraphic chart of the main miospore taxa.

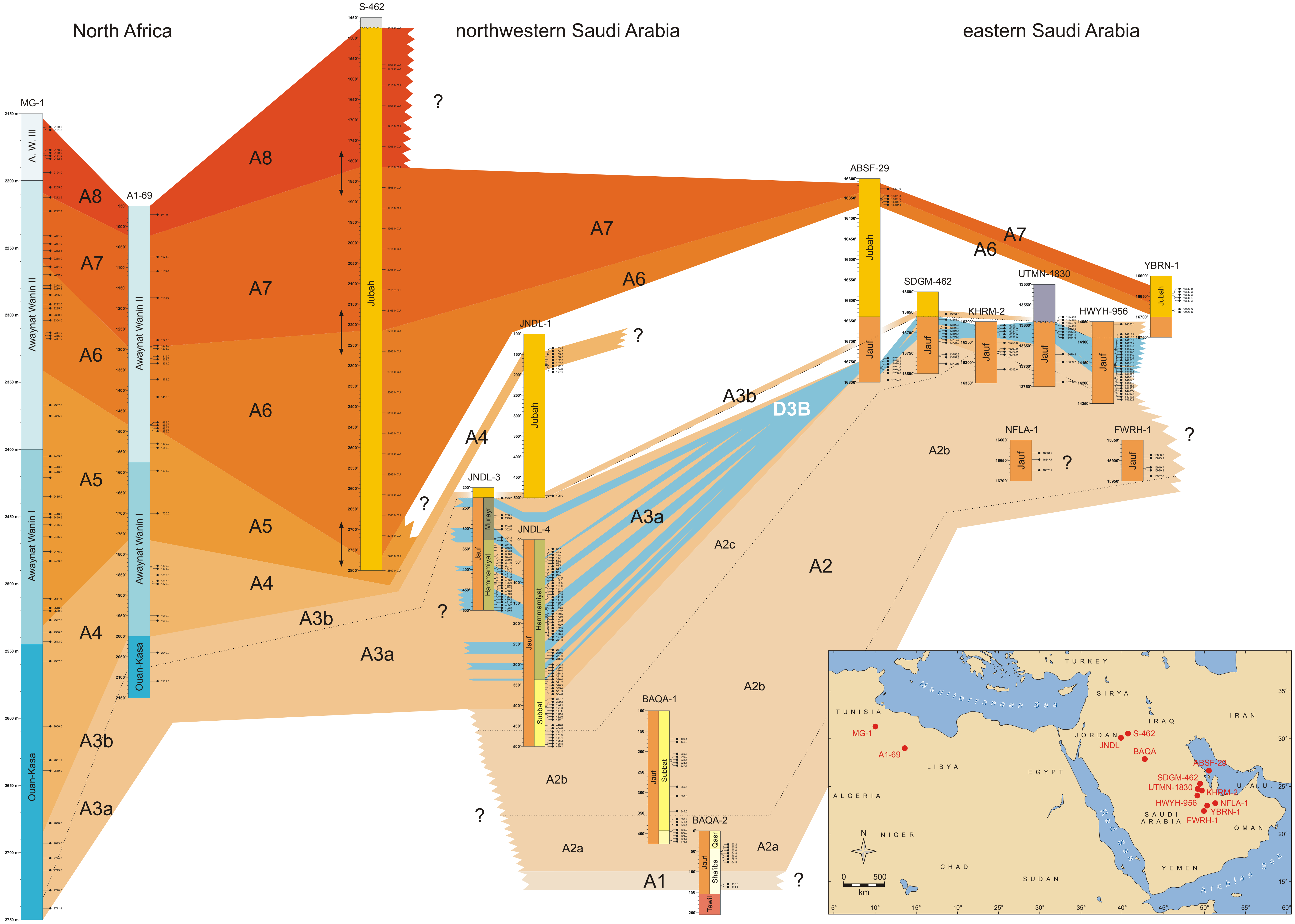

Fig. 4.2. Correlation between the studied sections on the basis of miospore assemblages.

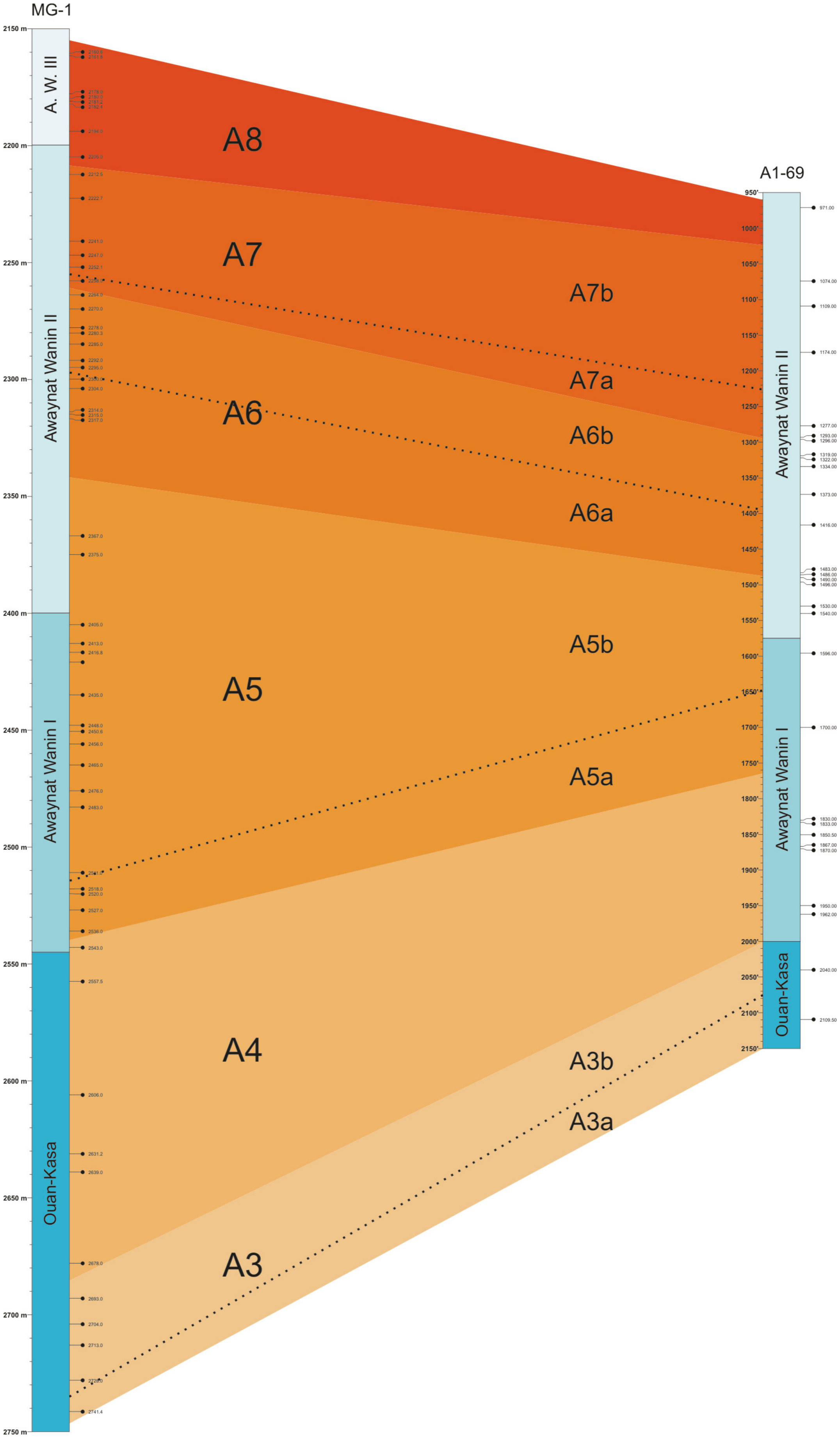

Fig. 4.3. Correlation in North Africa on the basis of the new biozonation.

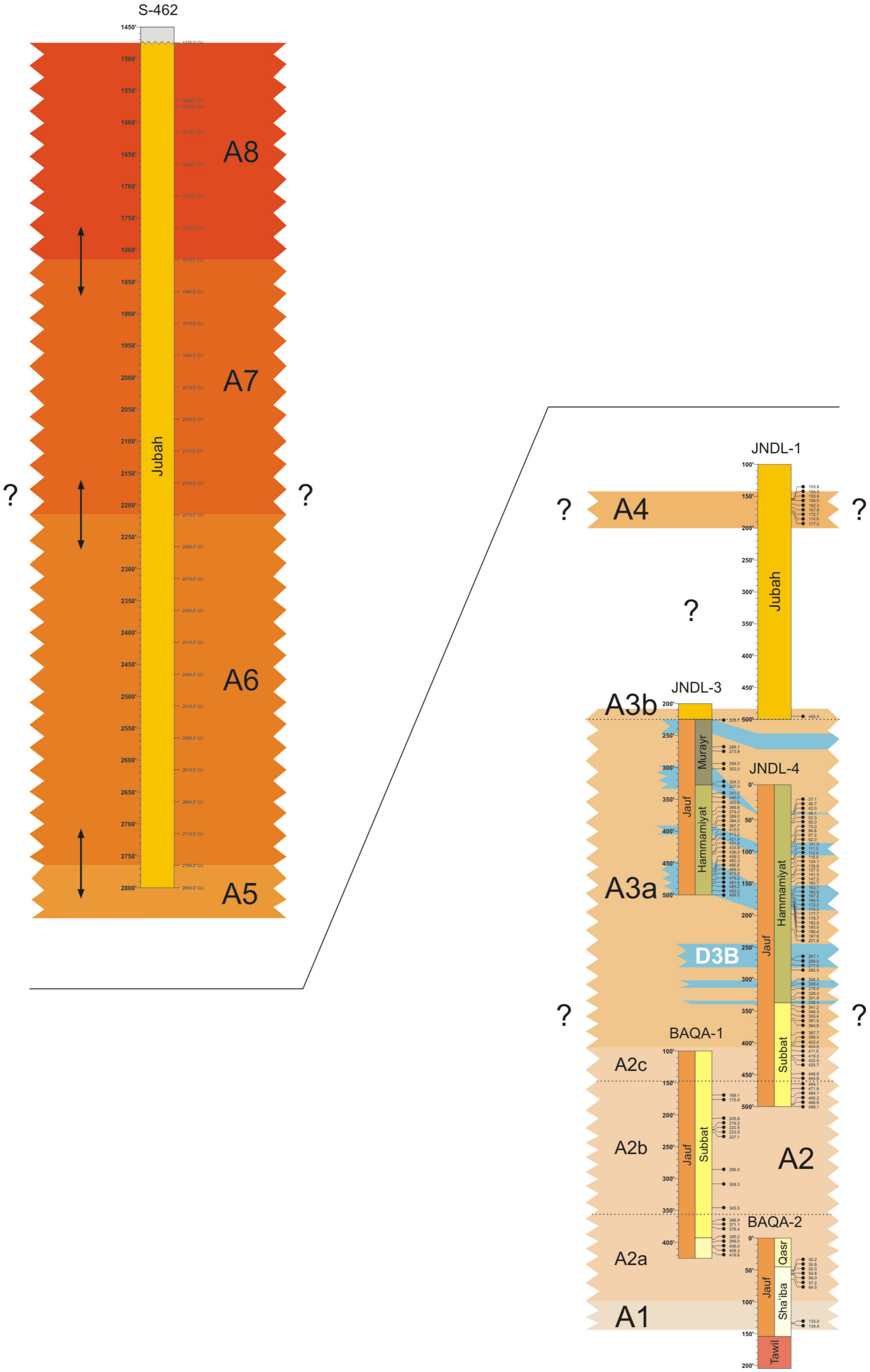

Fig. 4.4. Correlation in northwestern Saudi Arabia on the basis of the new biozonation.

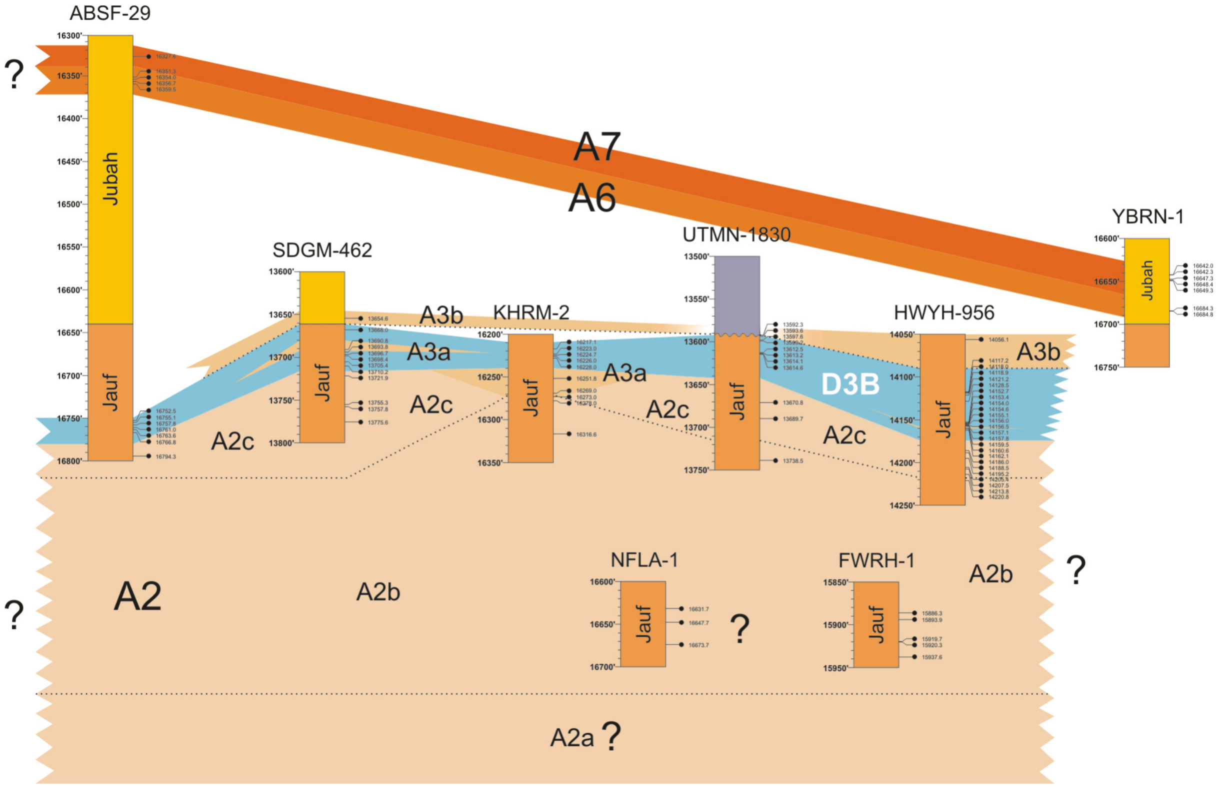

Fig. 4.5. Correlation in eastern Saudi Arabia on the basis of the new biozonation.

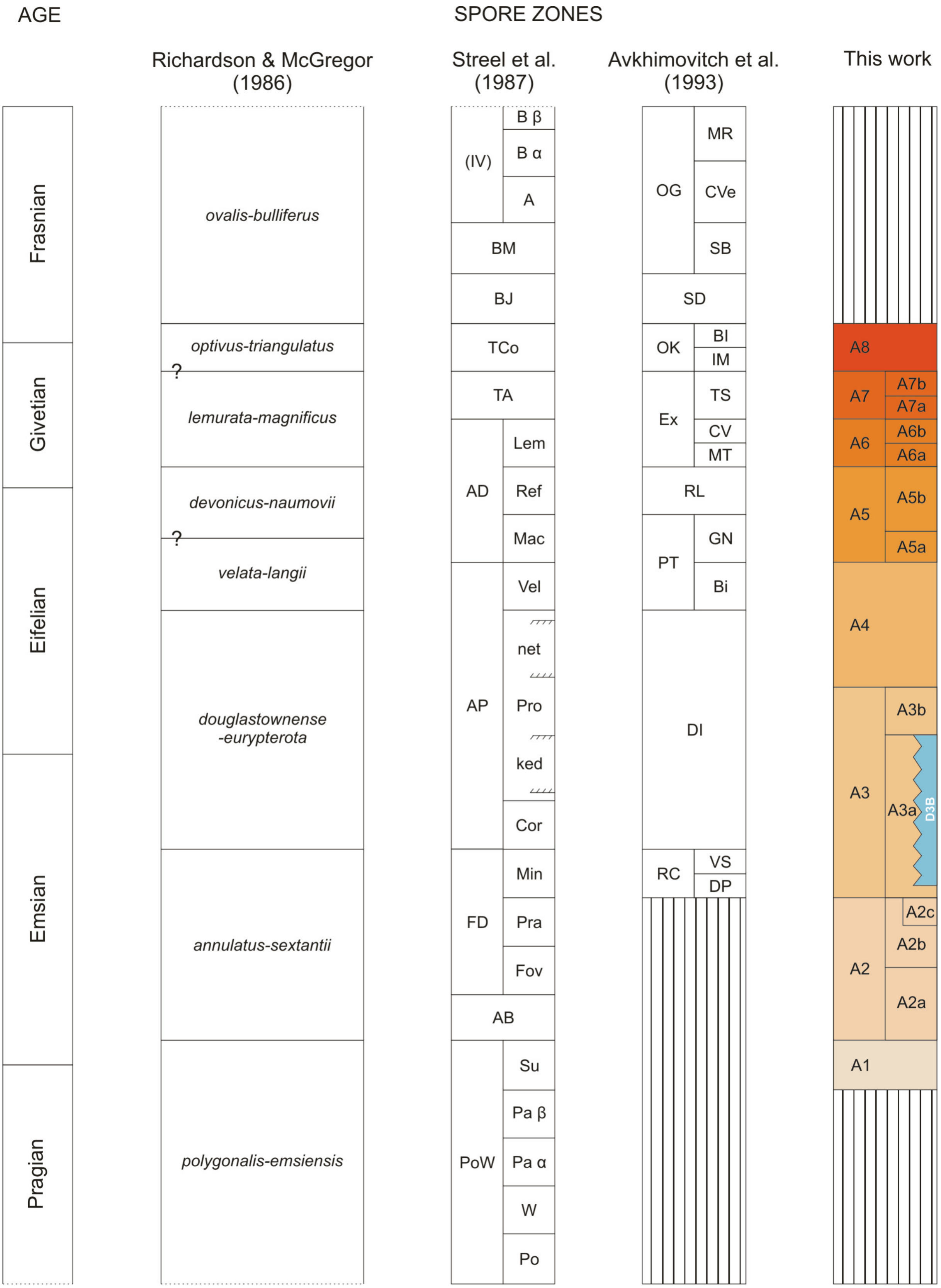

Fig. 4.6. Comparisons of the new biozonation from northwestern Gondwana with the miospore zonations from Euramerica (Richardson & McGregor, 1986; Streel et al., 1987; Avkhimovitch et al., 1993).

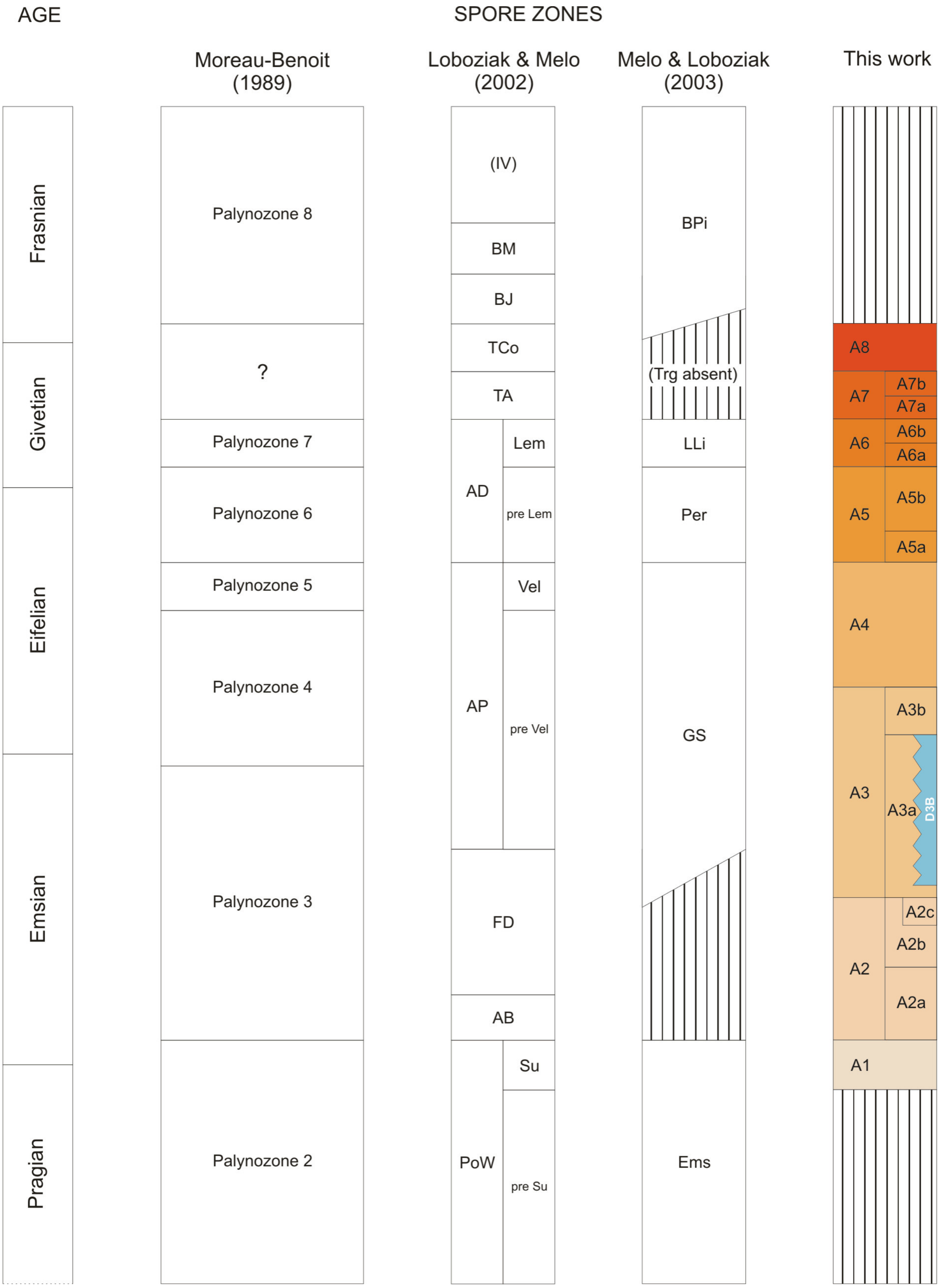

Fig. 4.7. Comparisons of the new biozonation from northwestern Gondwana with the most complete miospore zonations from western Gondwana (Moreau-Benoit, 1989; Loboziak & Melo, 2002; Melo & Loboziak, 2003).

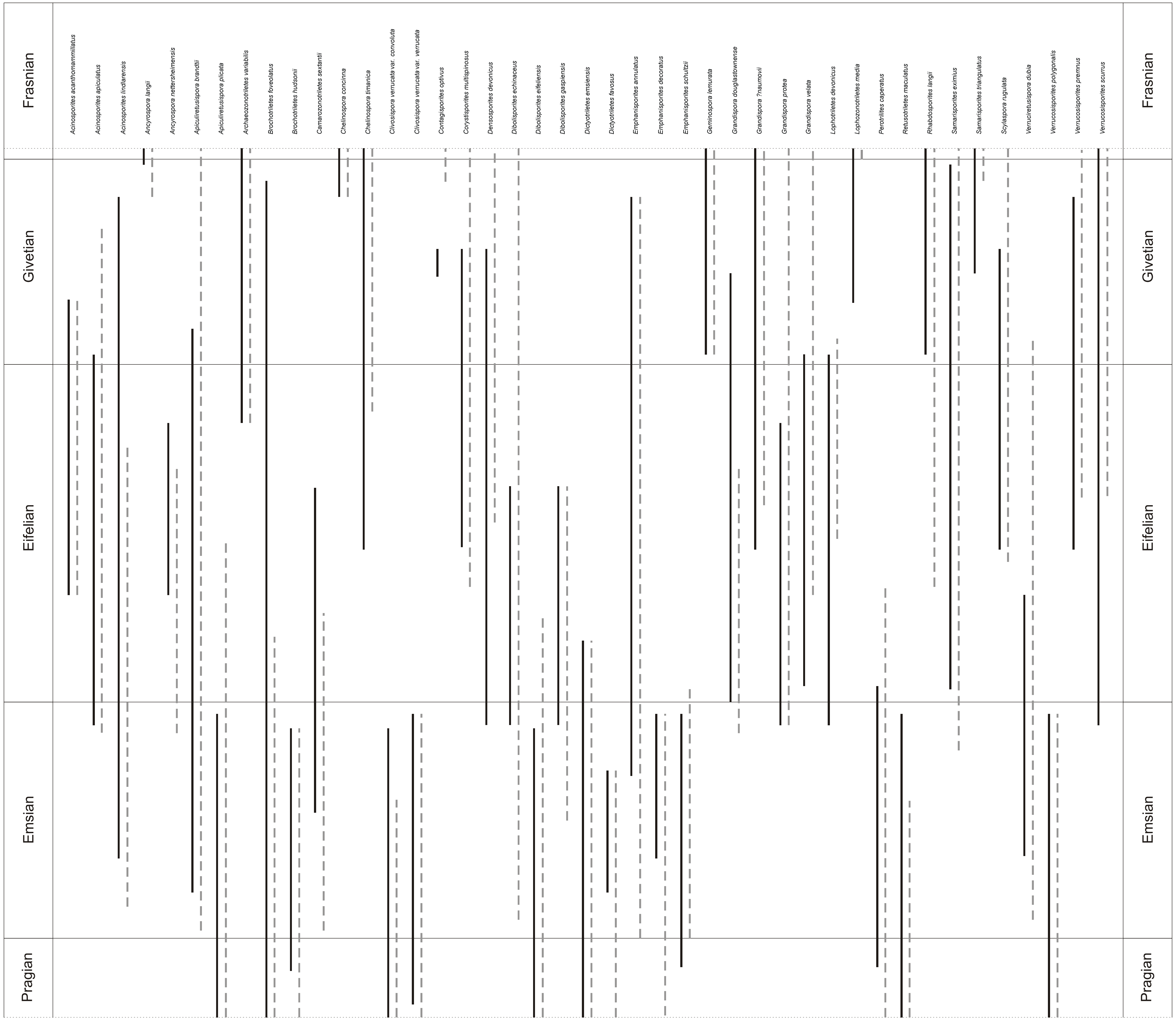

Fig. 4.8. Comparisons of ranges of some common species in northwestern Gondwana (continuous lines) and Euramerica (dotted lines). Stratigraphic ranges of species in Euramerica come from Richardson & McGregor (1986).

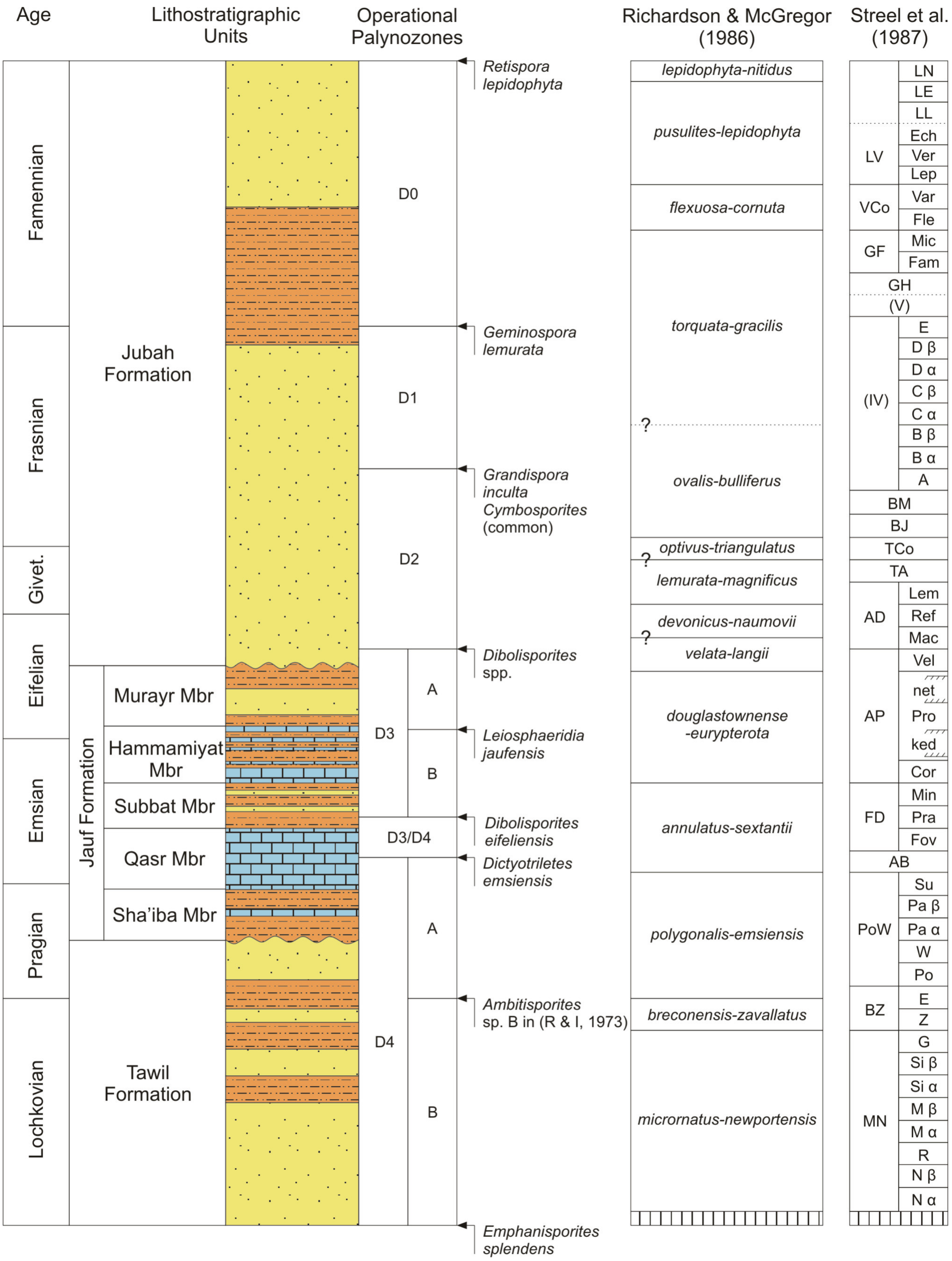

Fig. 5.1. Operational palynological zonation in Saudi Arabia compared with the standard Euramerican zonation of Richardson & McGregor (1986) and Streel et al. (1987) (modified after Al-Hajri et al., 1999).

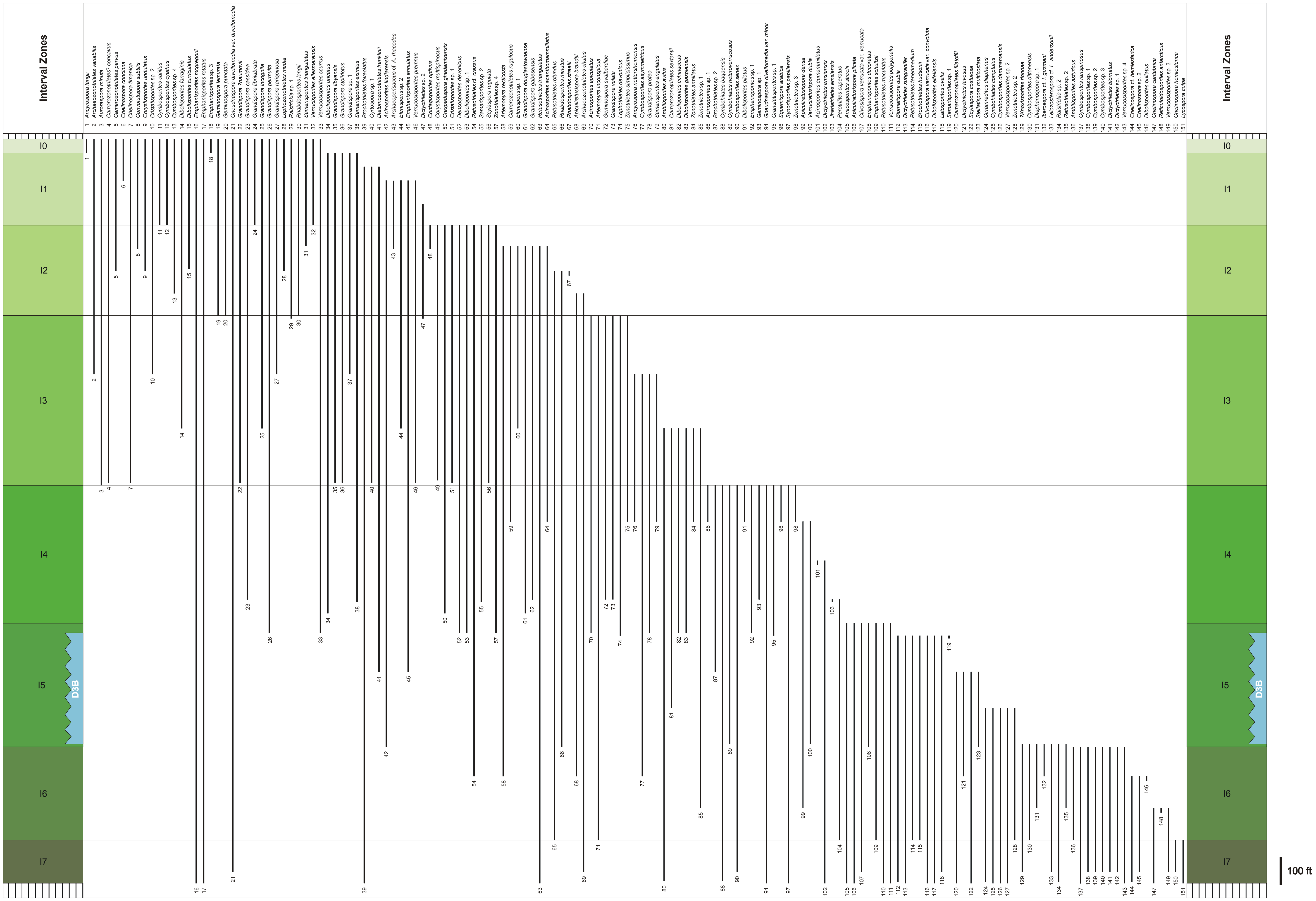

Fig. 5.2. Composite stratigraphic chart of the main miospore taxa for the new provisional downward biozonation. Stratigraphic ranges sorted according to their first-downhole occurrence.

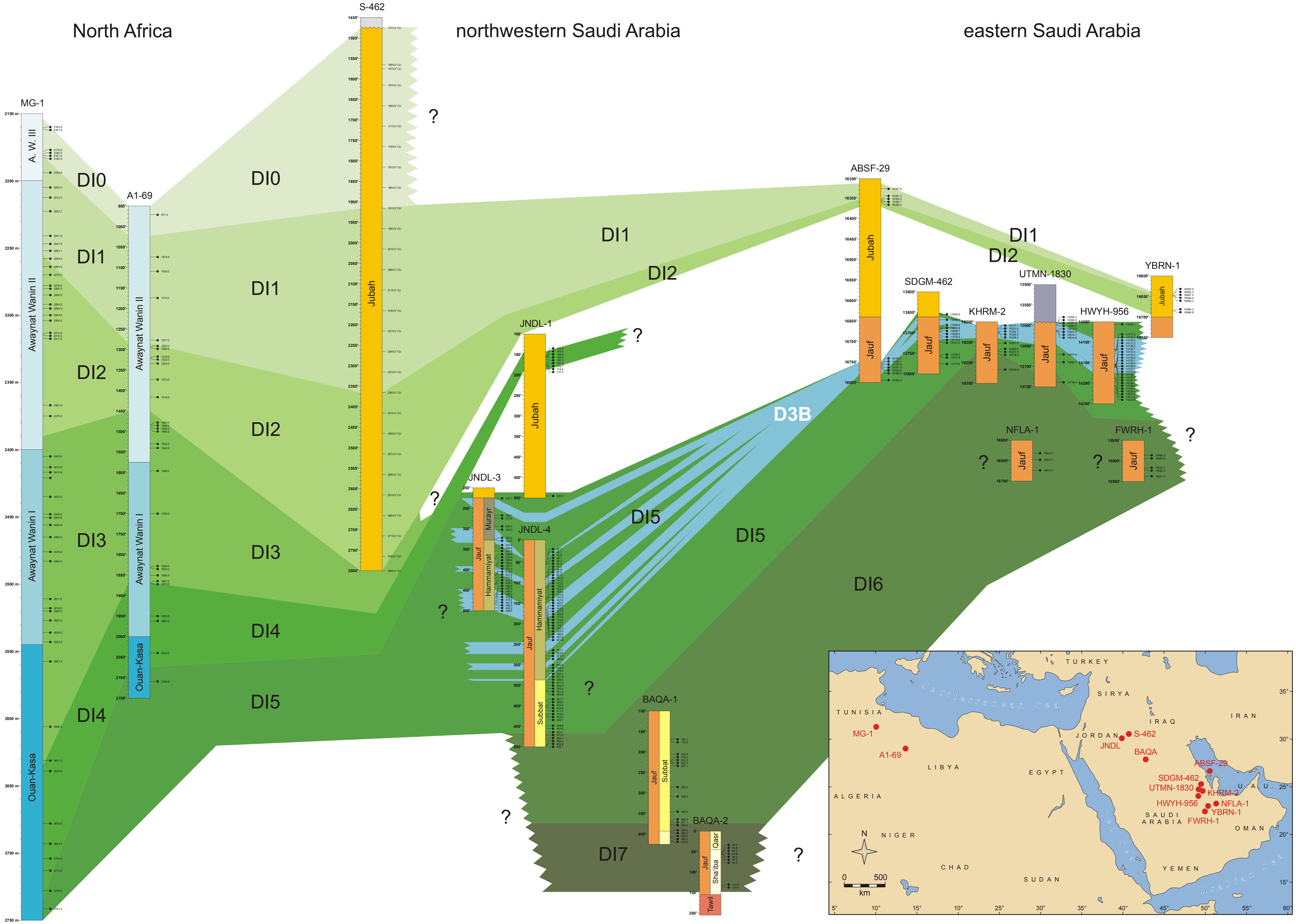

Fig. 5.3. Correlation between the studied sections on the basis of the downward biozonation.

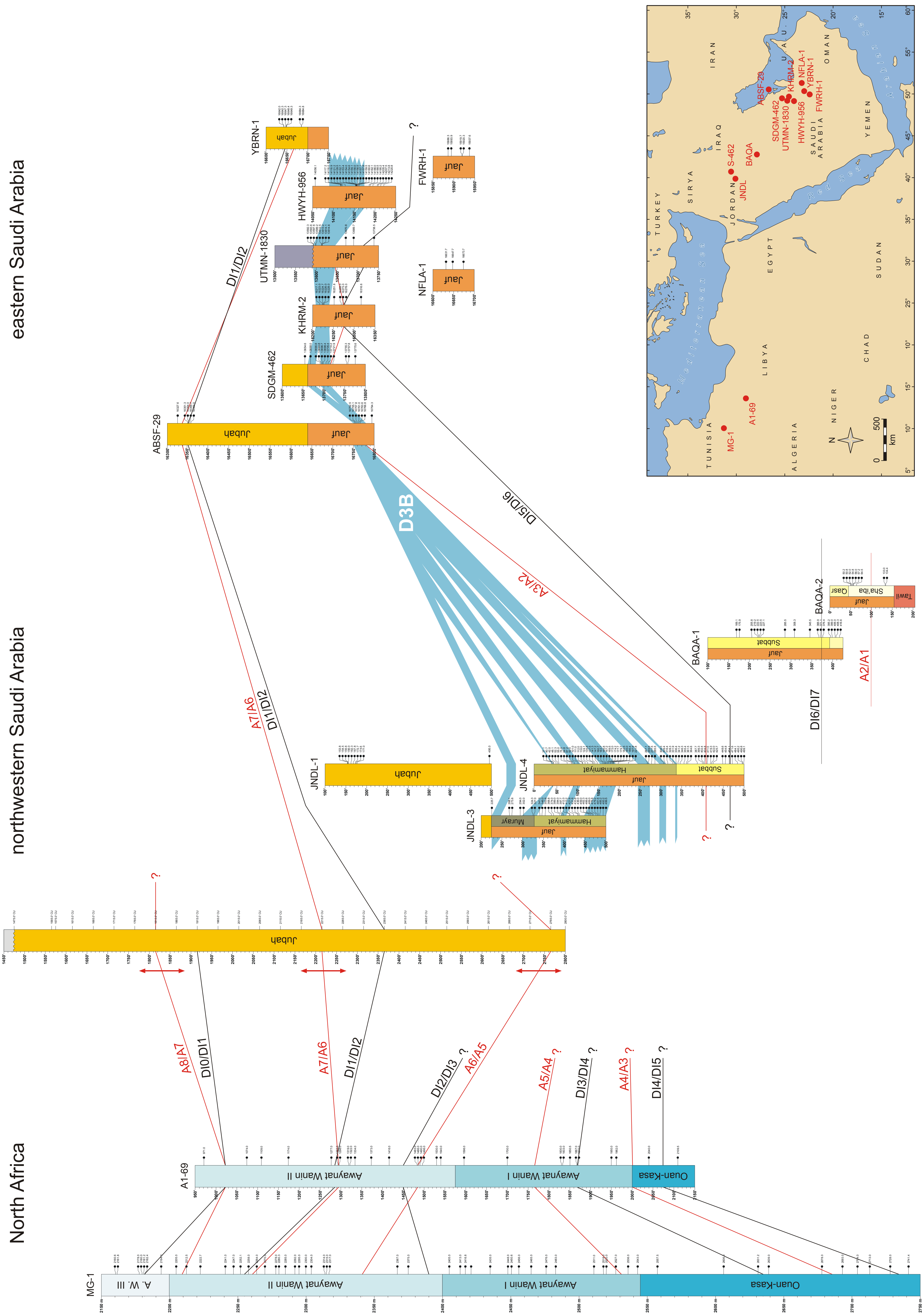

Fig. 5.4. Comparisons between the correlations according either the upward or downward biozonation.

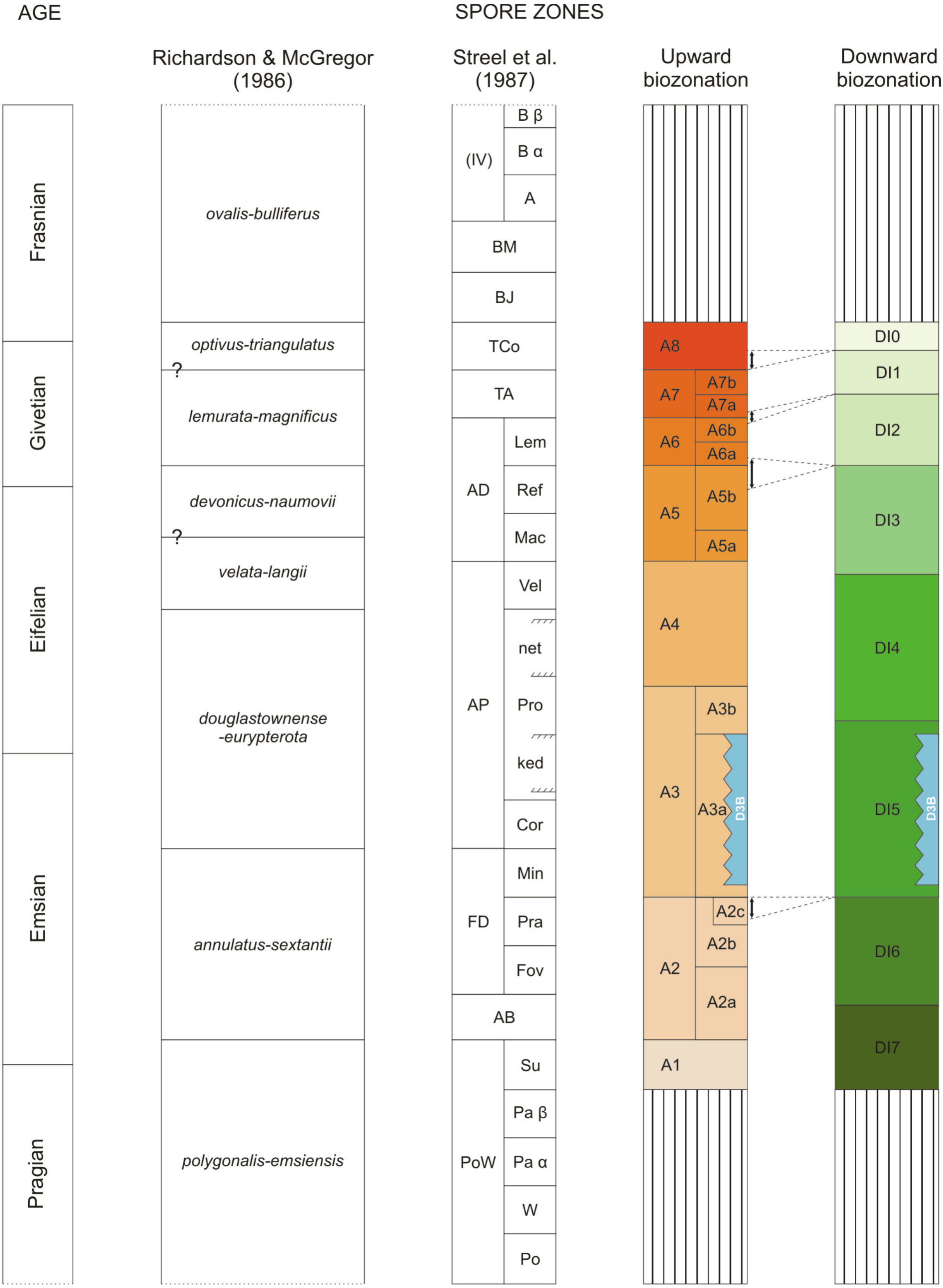

Fig. 5.5. Comparisons of the upward and downward biozonations from northwestern Gondwana with the miospore zonations from Euramerica (Richardson & McGregor, 1986; Streel et al., 1987).

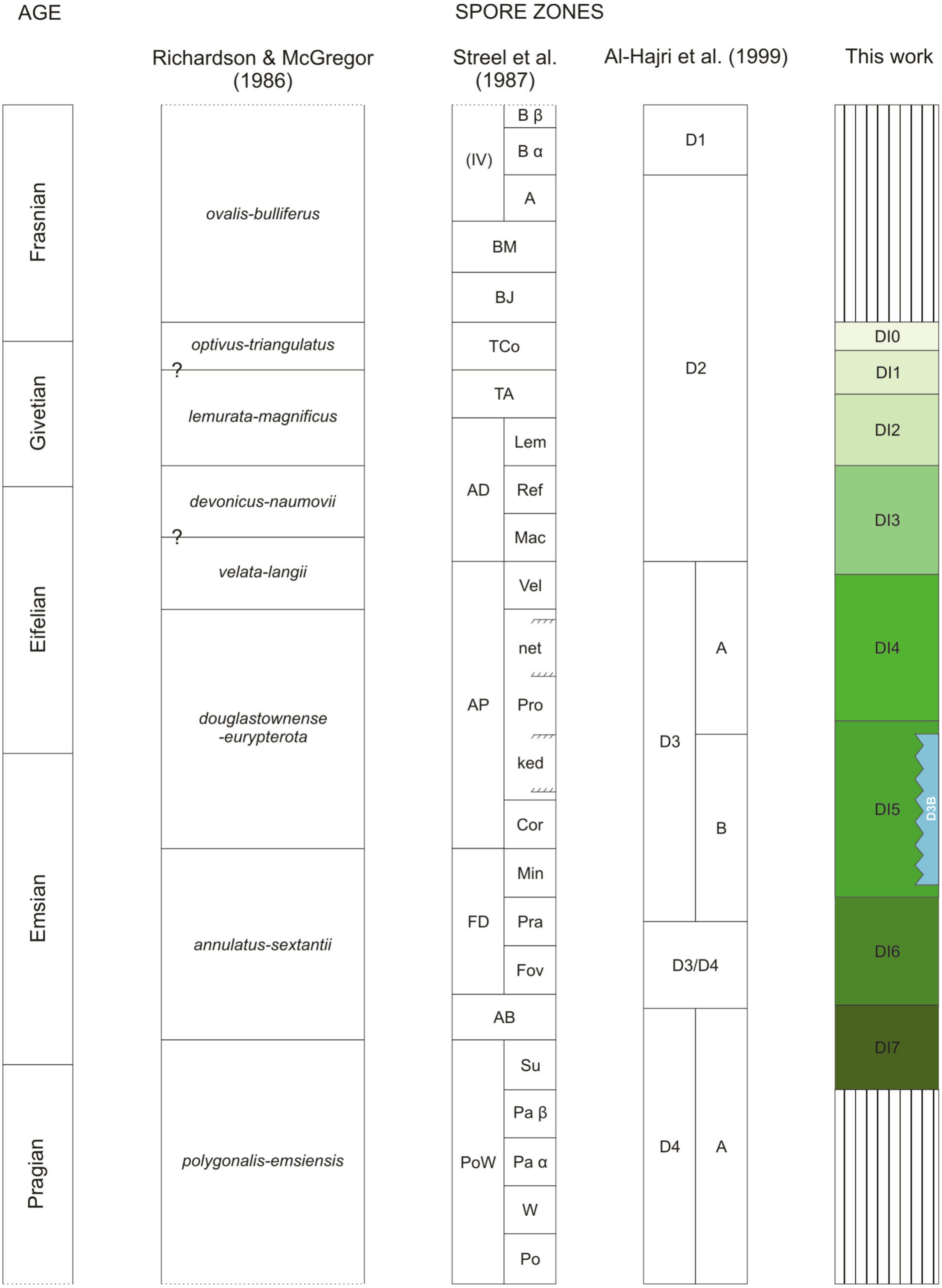

Fig. 5.6. Comparisons of the new provisional downward biozonation from northwestern Gondwana with the operational palynological zonation of Al-Hajri et al. (1999) which was calibrated with the miospore zonations from Euramerica (Richardson & McGregor, 1986; Streel et al., 1987).

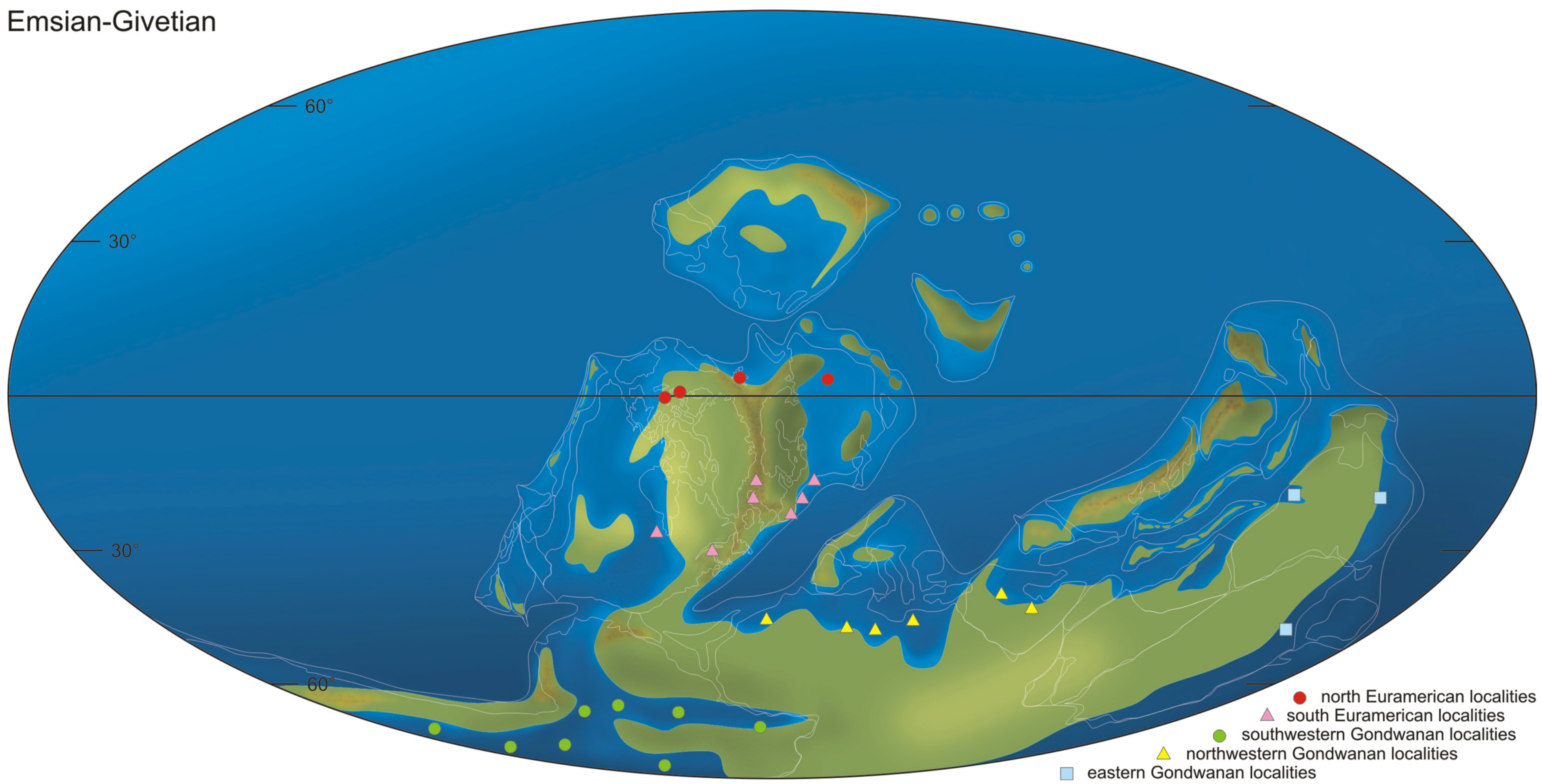

Fig. 6.1. Location of Emsian-Givetian miospore assemblages used for the calculation of the coefficients of similarity. Palaeogeographic reconstruction modified after Scotese (2000).

Number of species in common between 2 regions	northern Euramerica	southern Euramerica	southwestern Gondwana	northwestern Gondwana	eastern Gondwana
northern Euramerica	271	95	48	79	51
southern Euramerica	95	299	62	103	41
southwestern Gondwana	48	62	123	76	32
northwestern Gondwana	79	103	76	299	55
eastern Gondwana	51	41	32	55	198

Fig. 6.2. Matrix of numbers of species in common between two compared regions. The total numbers of species for each region are distributed diagonally.

CS	northern Euramerica	southern Euramerica	southwestern Gondwana	northwestern Gondwana	eastern Gondwana
northern Euramerica	1	0.34	0.24	0.28	0.22
southern Euramerica	0.34	1	0.29	0.34	0.16
southwestern Gondwana	0.24	0.29	1	0.36	0.20
northwestern Gondwana	0.28	0.34	0.36	1	0.22
eastern Gondwana	0.22	0.16	0.20	0.22	1

Fig. 6.3. Matrix of coefficient of similarities (CS) calculated between two compared regions.

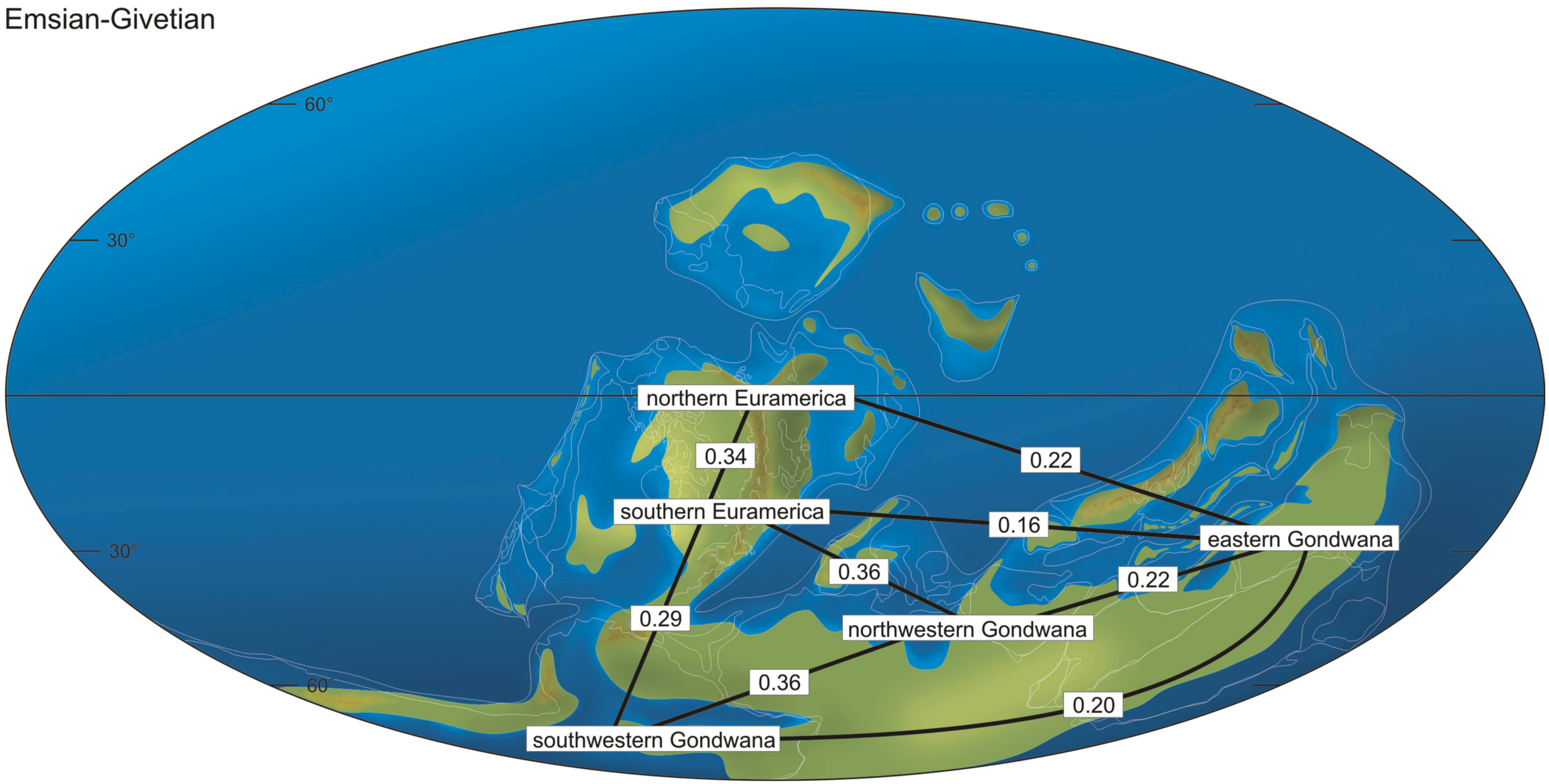

Fig. 6.4. Coefficients of similarity between the different regions calculated on the basis of Emsian-Givetian miospore assemblages. Palaeogeographic reconstruction modified after Scotese (2000).

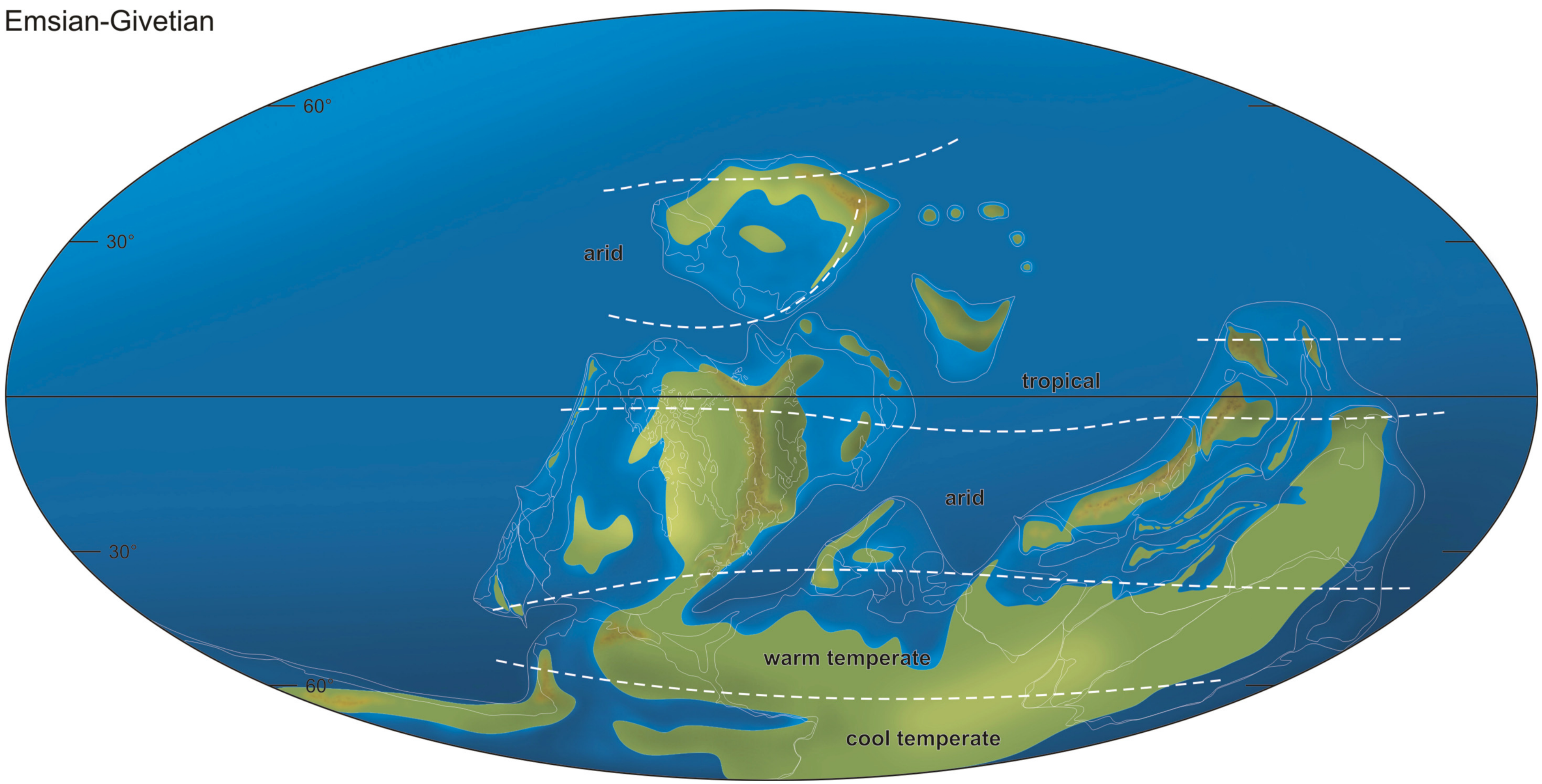

Fig. 6.5. Climatic belts and palaeogeographic reconstruction modified after Scotese (2000).

Main genera and miospore types	N Euramerica tropical assemblages	S Euramerica arid assemblages	NW Gondwana warm temperate assemblages	SW Gondwana cool temperate assemblages
Acanthotriletes	2	2	1	0
Acinosporites	4	13	8	8
Ambitisporites	0	1	3	1
Amicosporites	0	2	2	0
Ancyrospora	18	13	6	1
Aneurospora	1	6	4	0
Apiculiretusispora type	21	13	15	9
Archaeoperisaccus	3	0	2	1
Archaeozonotriletes	7	4	3	2
Auroraspora type	2	3	3	1
Biornatispora	0	4	5	0
Brochotriletes	0	8	7	1
Calamospora	4	4	3	0
Camarozonotriletes	7	2	6	4
Chelinospora	4	5	10	3
Cirratriradites	3	6	1	1
Clivosispora	0	2	2	1
Contagisporites	1	1	1	0
Convolutispora	7	3	3	3
Corystisporites	6	7	4	1
Craspedispora	2	0	4	2
Cymbohilates	0	1	4	0
Cymbosporites	6	10	14	8
Densosporites	5	3	2	0
Diatomozonotriletes	2	0	2	1
Dibolisporites type	10	21	15	9
Dictyotriletes	2	6	10	4
Emphanisporites	6	16	14	8
Geminospora	18	7	9	3
Grandispora	21	23	24	16
Hystrocosporites	15	14	5	1
Iberoespora	0	0	3	0
Kraeuselisporites	5	5	0	0
Laevigate monolete spores	1	1	2	1
Laevigate zonate spores	0	1	8	1
Leiotriletes	2	4	1	3
Lophotriletes	2	0	1	0
Lophozonotriletes	1	0	6	0
Nikitinsporites	1	0	0	0
Perotrilites	10	10	4	1
Punctatisporites	7	4	1	2
Raistrickia	1	2	3	2
Retispora	1	2	0	0
Retusotriletes	16	22	17	3
Rhabdosporites	5	3	3	1
Samarisporites type	10	8	12	3
Stenozonotriletes	4	4	1	0
Synorisporites type	0	2	4	2
Verrucate spores	6	11	12	6
Total diversity	271	299	299	123

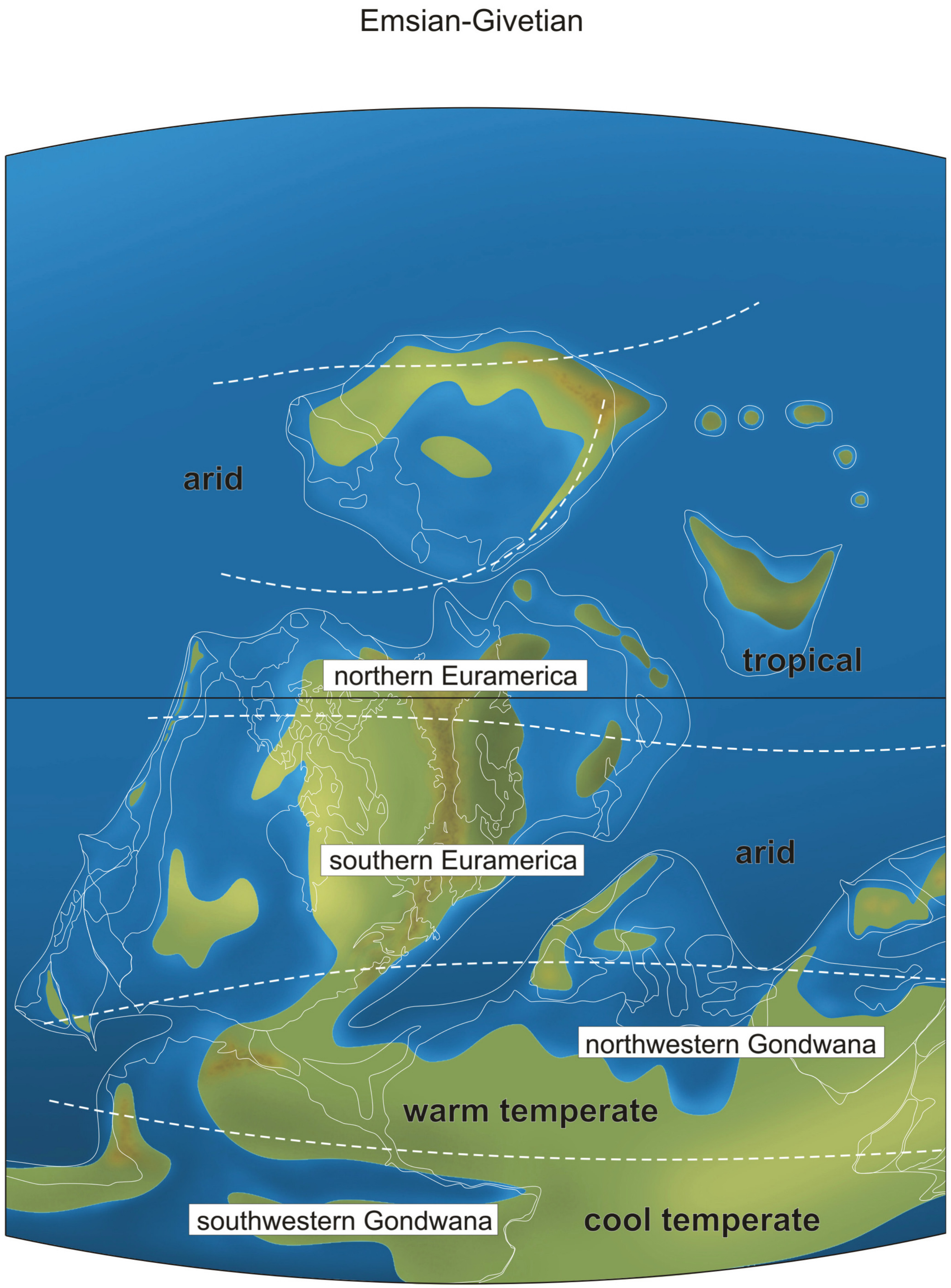

Fig. 6.6. Distribution and diversity of the main genera and miospore types according to the different regions and climatic belts during the Emsian-Givetian interval.

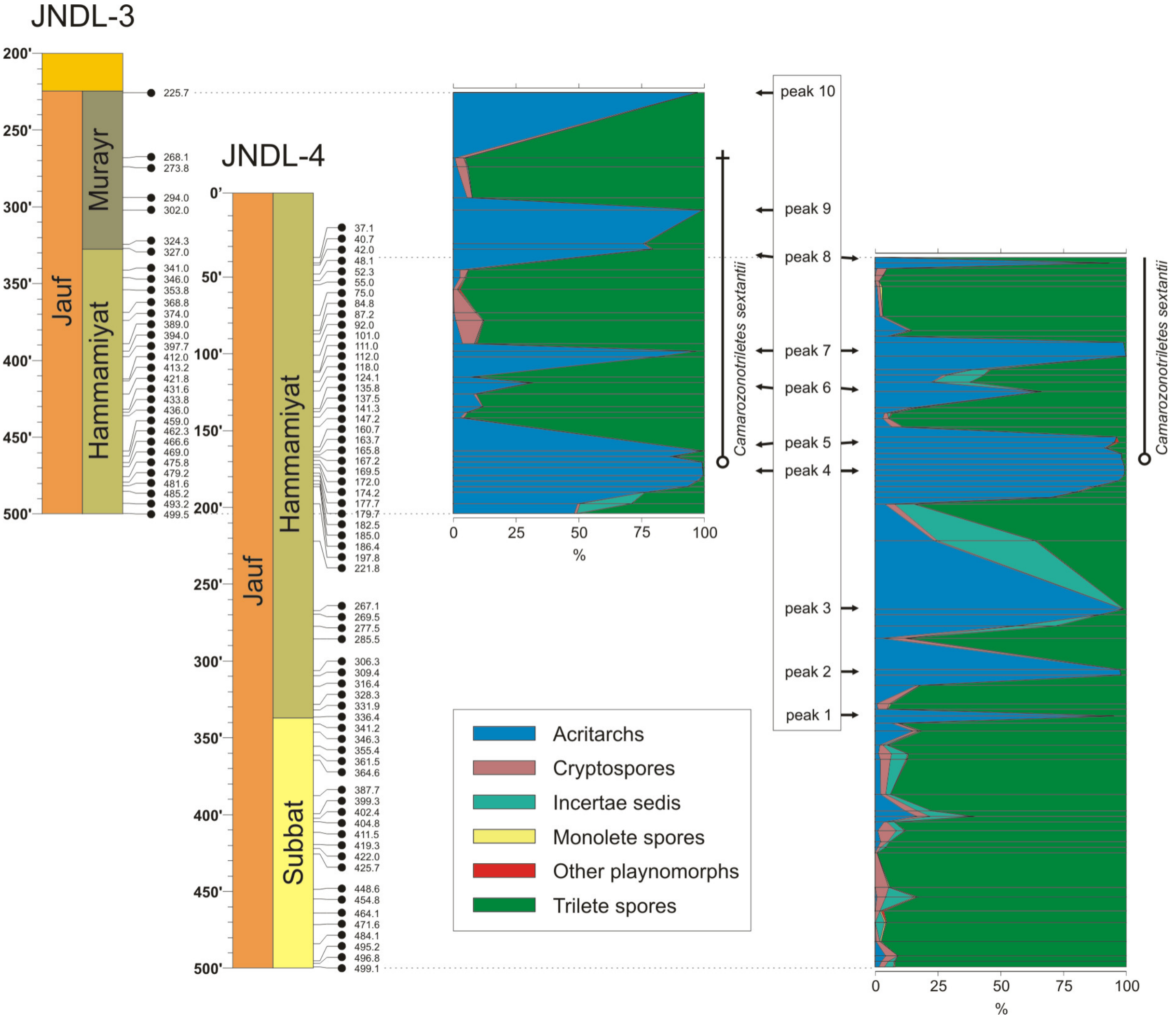

Fig. 6.7. Correlation within the D3B interval between boreholes JNDL-3 and JNDL-4 on the basis of palynofacies.

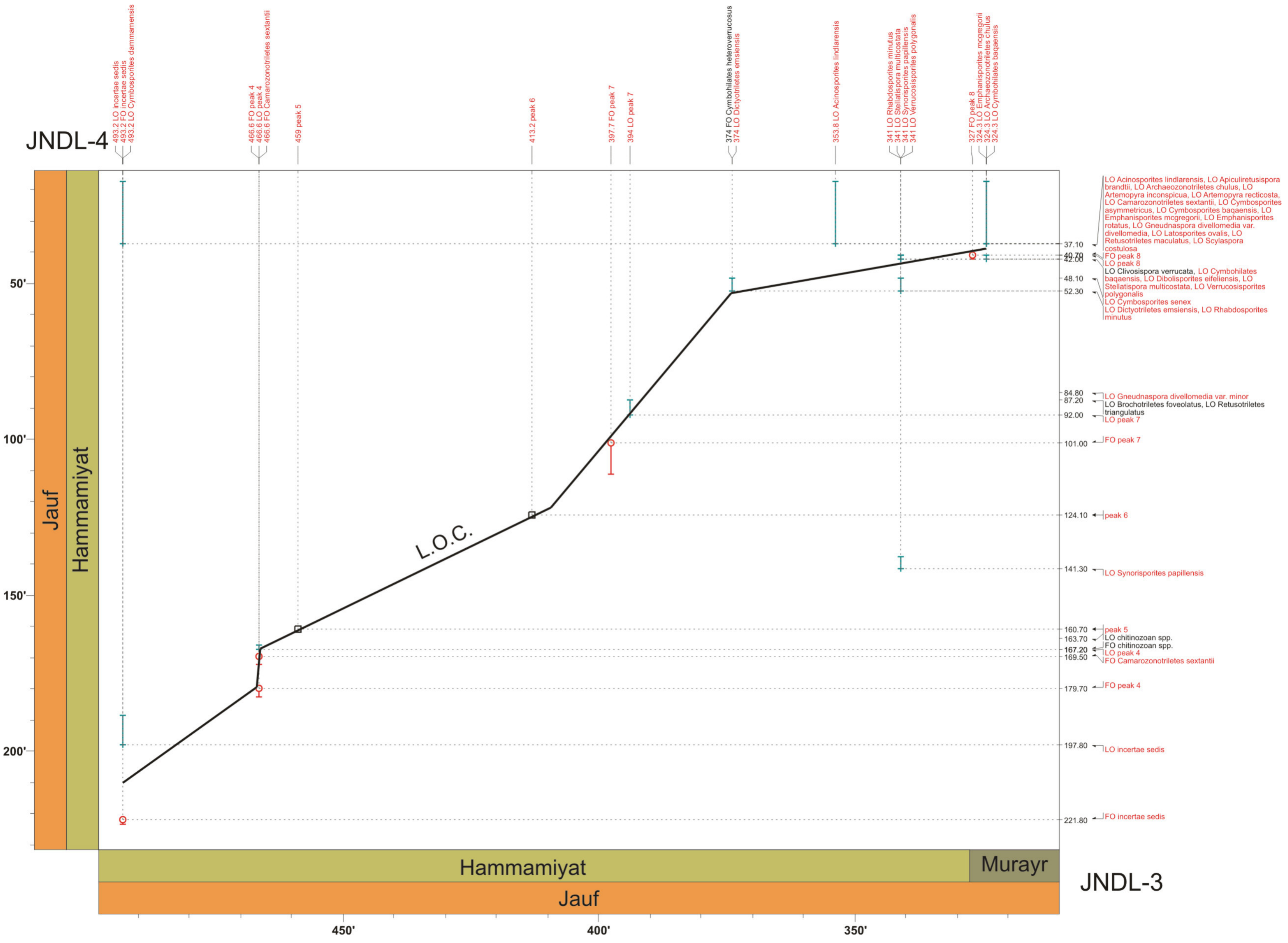

Fig. 6.8. Graphic correlation between boreholes JNDL-3 and JNDL-4. L.O.C.: line of correlation; FO: first occurrence; LO: last occurrence; events in red: common in the two sections; events in black: occurring only in a single section.

Appendix 1.1. List of miospore morphological groups.

Trilete spores

Acinosporites acanthomammillatus
Acinosporites apiculatus
Acinosporites eumammillatus
Acinosporites hirsutus
Acinosporites lindlarensis
Acinosporites sp. 1
Acinosporites spp.
Alatisporites sp. 1
Ambitisporites asturicus
Ambitisporites avitus
Ambitisporites eslae
Amicosporites jonkeri
Amicosporites spp.
Amicosporites streelii
Ancyrospora langii
Ancyrospora nettersheimensis
Aneurospora cf. *A. bollandensis*
Aneurospora spp.
Apiculiretusispora brandtii
Apiculiretusispora densa
Apiculiretusispora plicata
Apiculiretusispora spp.
Archaeozonotriletes chulus
Archaeozonotriletes variabilis
Archaeozonotriletes spp.
Auroraspora macromanifesta
Auroraspora minuta
Biornatispora dubia
Biornatispora sp. 1
Biornatispora spp.
Brochotriletes bellatulus
Brochotriletes foveolatus
Brochotriletes hudsonii
Brochotriletes robustus
Brochotriletes sp. 1
Brochotriletes sp. 2
Camarozonotriletes filatoffii
Camarozonotriletes parvus
Camarozonotriletes rugulosus
Camarozonotriletes sextantii
Camarozonotriletes sp. 1
Camarozonotriletes? *concavus*
Chelinospora cantabrica
Chelinospora concinna
Chelinospora hemiesferica
Chelinospora cf. *hemiespherica*
Chelinospora sanpetrensis
Chelinospora timanica
Chelinospora sp. 1
Chelinospora sp. 2
Chelinospora sp. 3
Chelinospora spp.
Cirratriradites diaphanus

Clivosispora verrucata var. *convoluta*
Clivosispora verrucata var. *verrucata*
Concentricosisporites sagittarius
Convolutispora subtilis
Corystisporites collaris
Corystisporites multispinosus
Corystisporites undulatus
Craspedispora ghadamisensis
Craspedispora sp.
Cristatisporites sp. 1
Cristatisporites sp. 2
Cymbosporites asymmetricus
Cymbosporites catillus
Cymbosporites cyathus
Cymbosporites dammamensis
Cymbosporites dittonensis
Cymbosporites echinatus
Cymbosporites ocularis
Cymbosporites rarispinosus
Cymbosporites senex
Cymbosporites sp. 1
Cymbosporites sp. 2
Cymbosporites sp. 3
Cymbosporites sp. 4
Cymbosporites spp.
Cyrtospora sp. 1
Densosporites devonicus
Diaphanospora sp. 1
Diatomozonotriletes franklinii
Dibolisporites bullatus
Dibolisporites echinaceus
Dibolisporites eifeliensis
Dibolisporites farraginis
Dibolisporites gaspiensis
Dibolisporites pilatus
Dibolisporites turriculatus
Dibolisporites uncatus
Dibolisporites sp. 1
Dibolisporites sp. 2
Dibolisporites sp. 3
Dibolisporites sp. 4
Dibolisporites sp. 5
Dibolisporites spp.
Dictyotriletes ?*gorgoneus*
Dictyotriletes biornatus
Dictyotriletes emsiensis
Dictyotriletes favosus
Dictyotriletes subgranifer
Dictyotriletes sp. 1
Dictyotriletes sp. 2
Dictyotriletes sp. 3
Dictyotriletes sp. 4
Dictyotriletes spp.
Elenisporis sp. 1
Elenisporis sp. 2

Emphanisporites annulatus
Emphanisporites cf. *E. biradiatus*
Emphanisporites decoratus
Emphanisporites cf. *E. edwardsiae*
Emphanisporites erraticus
Emphanisporites mcgregorii
Emphanisporites rotatus
Emphanisporites schultzii
Emphanisporites sp. 1
Emphanisporites sp. 2
Emphanisporites sp. 3
Emphanisporites spp.
Geminospora lemurata
Geminospora libyensis
Geminospora punctata
Geminospora svalbardiae
Geminospora sp. 1
Geminospora sp. 2
Geminospora spp.
Grandispora cassidea
Grandispora douglastownense
Grandispora fibrilabrata
Grandispora gabesensis
Grandispora incognita
Grandispora inculta
Grandispora libyensis
Grandispora ?*naumovii*
Grandispora permulta
Grandispora protea
Grandispora rarispinosa
Grandispora stolidotus
Grandispora velata
Grandispora sp. 1
Grandispora spp.
Granulatisporites sp. 1
Hystricosporites sp. 1
Hystricosporites sp. 2
Iberoespora cantabrica
Iberoespora glabella
Iberoespora cf. *I. guzmani*
?*Knoxisporites riondae*
Leiozosterospora cf. *L. andersonii*
Lophotriletes devonicus
Lophozonotriletes media
Lycospora culpa
Perotrilites caperatus
Raistrickia sp. 1
Raistrickia sp. 2
Raistrickia spp.
Retusotriletes cf. *R. crassus*
Retusotriletes goensis
Retusotriletes maculatus
Retusotriletes rotundus
Retusotriletes tenerimedium
Retusotriletes triangulatus

Retusotriletes sp. 1
Retusotriletes sp. 2
Retusotriletes spp.
Rhabdosporites langii
Rhabdosporites minutus
Rhabdosporites streelii
Samarisporites angulatus
Samarisporites eximius
Samarisporites triangulatus
Samarisporites sp. 1
Samarisporites sp. 2
Samarisporites sp. 3
Samarisporites sp. 4
Samarisporites spp.
Scylaspora costulosa
Scylaspora rugulata
Scylaspora cf. *S. scripta*
Squamispora arabica
Stellatispora multicostata
Synorisporites cf. *S. lobatus*
Synorisporites papillensis
Synorisporites verrucatus
Synorisporites spp.
Verruciretusispora dubia
Verrucosisporites polygonalis
Verrucosisporites premnus
Verrucosisporites scurrus
Verrucosisporites sp. 1
Verrucosisporites sp. 2
Verrucosisporites sp. 3
Verrucosisporites sp. 4
Verrucosisporites spp.
Zonotriletes armillatus
Zonotriletes simplicissimus
Zonotriletes sp. 1
Zonotriletes sp. 2
Zonotriletes sp. 3
Zonotriletes sp. 4
Zonotriletes sp. 5
Zonotriletes sp. 6
Zonotriletes spp.

Monolete spores

Archaeoperissacus cf. *A. rhacodes*
Devonomonoletes sp. 1
Latosporites ovalis
Latosporites sp. 1
Reticuloidosporites antarcticus

Cryptospores

Artemopyra inconspicua
Artemopyra recticosta
Cymbohilates baqaensis
Cymbohilates comptulus
Cymbohilates cymosus

Cymbohilates heteroverrucosus
Cymbohilates sp. 1
Dyadospora murusattenuata
Gneudnaspora divellomedia var. *divellomedia*
Gneudnaspora divellomedia var. *minor*
Tetrahedraletes medinensis

Megaspores
Contagisporites optivus
Jhariatriletes emsiensis
Verrucisporites ellesmerensis

Simple laevigate spores
Ambitisporites asturicus
Ambitisporites avitus
Archaeozonotriletes chulus
Archaeozonotriletes variabilis
Archaeozonotriletes spp.
Concentricosisporites sagittarius
Diaphanospora sp. 1
Dyadospora murusattenuata
Gneudnaspora divellomedia var. *divellomedia*
Gneudnaspora divellomedia var. *minor*
Latosporites ovalis
Latosporites sp. 1
Retusotriletes cf. *R. crassus*
Retusotriletes goensis
Retusotriletes rotundus
Retusotriletes tenerimedium
Retusotriletes triangulatus
Retusotriletes sp. 1
Retusotriletes sp. 2
Retusotriletes spp.
Squamispora arabica
Tetrahedraletes medinensis

Simple spores with discrete elements
Acinosporites acanthomammillatus
Acinosporites apiculatus
Acinosporites eumammillatus
Acinosporites hirsutus
Acinosporites lindlarensis
Acinosporites spp.
Aneurospora cf. *A. bollandensis*
Aneurospora spp.
Apiculiretusispora brandtii
Apiculiretusispora densa
Apiculiretusispora plicata
Apiculiretusispora spp.
Camarozonotriletes parvus
Camarozonotriletes sextantii
Camarozonotriletes sp. 1
Camarozonotriletes? *concavus*
Clivosispora verrucata var. *verrucata*
Corystisporites collaris

Corystisporites multispinosus
Corystisporites undulatus
Cymbohilates baqaensis
Cymbohilates comptulus
Cymbohilates cymosus
Cymbohilates heteroverrucosus
Cymbohilates sp. 1
Cymbosporites asymmetricus
Cymbosporites catillus
Cymbosporites cyathus
Cymbosporites dammamensis
Cymbosporites dittonensis
Cymbosporites echinatus
Cymbosporites ocularis
Cymbosporites rarispinosus
Cymbosporites senex
Cymbosporites sp. 1
Cymbosporites sp. 2
Cymbosporites sp. 3
Cymbosporites sp. 4
Cymbosporites spp.
Cyrtospora sp. 1
Devonomonoletes sp. 1
Diatomozonotriletes franklinii
Dibolisporites bullatus
Dibolisporites echinaceus
Dibolisporites eifeliensis
Dibolisporites farraginis
Dibolisporites gaspiensis
Dibolisporites pilatus
Dibolisporites turriculatus
Dibolisporites uncatus
Dibolisporites sp. 1
Dibolisporites sp. 2
Dibolisporites sp. 3
Dibolisporites sp. 4
Dibolisporites sp. 5
Dibolisporites spp.
Granulatisporites sp. 1
Hystricosporites sp. 1
Hystricosporites sp. 2
Jhariatriletes emsiensis
Lophotriletes devonicus
Lophozonotriletes media
Raistrickia sp. 1
Raistrickia sp. 2
Raistrickia spp.
Synorisporites verrucatus
Synorisporites spp.
Verruciretusispora dubia
Verrucosisporites polygonalis
Verrucosisporites premnus
Verrucosisporites scurrus
Verrucosisporites sp. 1
Verrucosisporites sp. 2

Verrucosisporites sp. 3
Verrucosisporites sp. 4
Verrucosisporites spp.

Reticulate/foveolate spores

Biornatispora dubia
Biornatispora sp. 1
Biornatispora spp.
Brochotriletes bellatulus
Brochotriletes foveolatus
Brochotriletes hudsonii
Brochotriletes robustus
Brochotriletes sp. 1
Brochotriletes sp. 2
Camarozonotriletes filatoffii
Chelinospora cantabrica
Chelinospora concinna
Dictyotriletes ?*gorgoneus*
Dictyotriletes biornatus
Dictyotriletes emsiensis
Dictyotriletes favosus
Dictyotriletes sp. 1
Dictyotriletes sp. 2
Dictyotriletes sp. 3
Dictyotriletes sp. 4
Dictyotriletes spp.
Dictyotriletes subgranifer
Reticuloidosporites antarcticus
Verrucisporites ellesmerensis

Radial-patterned spores

Artemopyra inconspicua
Artemopyra recticosta
Elenisporis sp. 1
Elenisporis sp. 2
Emphanisporites annulatus
Emphanisporites cf. *E. biradiatus*
Emphanisporites decoratus
Emphanisporites cf. *E. edwardsiae*
Emphanisporites erraticus
Emphanisporites mcgregorii
Emphanisporites rotatus
Emphanisporites schultzii
Emphanisporites sp. 1
Emphanisporites sp. 2
Emphanisporites sp. 3
Emphanisporites spp.
Scylaspora cf. *S. scripta*
Scylaspora costulosa
Scylaspora rugulata
Stellatispora multicostata

Papillate spores

Ambitisporites eslae
Cirratriradites diaphanus

Iberoespora cantabrica
Iberoespora glabella
?*Knoxisporites riondae*
Retusotriletes maculatus
Synorisporites papillensis

Spores with anchor elements

Ancyrospora langii
Ancyrospora nettersheimensis
Hystricosporites sp. 1
Hystricosporites sp. 2

Spores with concentric structure

Amicosporites jonkeri
Amicosporites spp.
Amicosporites streelii
Emphanisporites annulatus
Emphanisporites erraticus
?*Knoxisporites riondae*
Synorisporites cf. *S. lobatus*
Zonotriletes armillatus
Zonotriletes sp. 4

Convolute/rugulate sores

Camarozonotriletes rugulosus
Chelinospora hemiesferica
Chelinospora cf. *hemiespherica*
Chelinospora sanpetrensis
Chelinospora timanica
Chelinospora sp. 1
Chelinospora sp. 2
Chelinospora sp. 3
Chelinospora spp.
Clivosispora verrucata var. *convoluta*
Convolutispora subtilis
Iberoespora cf. *I. guzmani*

Spores of uniform thickness

Acinosporites acanthomammillatus
Acinosporites apiculatus
Acinosporites eumammillatus
Acinosporites hirsutus
Acinosporites lindlarensis
Acinosporites spp.
Apiculiretusispora brandtii
Apiculiretusispora densa
Apiculiretusispora plicata
Apiculiretusispora spp.
Artemopyra inconspicua
Artemopyra recticosta
Biornatispora dubia
Biornatispora sp. 1
Biornatispora spp.
Brochotriletes sp. 2
Convolutispora subtilis

Corystisporites collaris
Corystisporites multispinosus
Corystisporites undulatus
Cymbohilates baqaensis
Cymbohilates comptulus
Cymbohilates cymosus
Cymbohilates heteroverrucosus
Cymbohilates sp. 1
Devonomonoletes sp. 1
Diaphanospora sp. 1
Diatomozonotriletes franklinii
Dibolisporites bullatus
Dibolisporites echinaceus
Dibolisporites eifeliensis
Dibolisporites farraginis
Dibolisporites gaspiensis
Dibolisporites pilatus
Dibolisporites turriculatus
Dibolisporites uncatus
Dibolisporites sp. 1
Dibolisporites sp. 2
Dibolisporites sp. 3
Dibolisporites sp. 4
Dibolisporites sp. 5
Dibolisporites spp.
Dictyotriletes ?*gorgoneus*
Dictyotriletes emsiensis
Dictyotriletes favosus
Dictyotriletes subgranifer
Dictyotriletes sp. 2
Dictyotriletes sp. 3
Dictyotriletes spp.
Dyadospora murusattenuata
Elenisporis sp. 1
Elenisporis sp. 2
Emphanisporites annulatus
Emphanisporites cf. *E. biradiatus*
Emphanisporites decoratus
Emphanisporites cf. *E. edwardsiae*
Emphanisporites erraticus
Emphanisporites mcgregorii
Emphanisporites rotatus
Emphanisporites schultzii
Emphanisporites sp. 1
Emphanisporites sp. 2
Emphanisporites sp. 3
Emphanisporites spp.
Gneudnaspora divellomedia var. *divellomedia*
Gneudnaspora divellomedia var. *minor*
Granulatisporites sp. 1
Hystricosporites sp. 1
Hystricosporites sp. 2
Jhariatriletes emsiensis
Latosporites ovalis
Latosporites sp. 1

Lophotriletes devonicus
Raistrickia sp. 1
Raistrickia sp. 2
Raistrickia spp.
Reticuloidosporites antarcticus
Retusotriletes cf. *R. crassus*
Retusotriletes goensis
Retusotriletes maculatus
Retusotriletes rotundus
Retusotriletes tenerimedium
Retusotriletes triangulatus
Retusotriletes sp. 1
Retusotriletes sp. 2
Retusotriletes spp.
Scylaspora costulosa
Scylaspora rugulata
Scylaspora cf. *S. scripta*
Squamispora arabica
Stellatispora multicostata
Tetrahedraletes medinensis
Verruciretusispora dubia
Verrucisporites ellesmerensis
Verrucosisporites polygonalis
Verrucosisporites premnus
Verrucosisporites scurrus
Verrucosisporites sp. 1
Verrucosisporites sp. 2
Verrucosisporites sp. 3
Verrucosisporites sp. 4
Verrucosisporites spp.

Cingulate spores
Ambitisporites asturicus
Ambitisporites avitus
Ambitisporites eslae
Aneurospora cf. *A. bollandensis*
Aneurospora spp.
Camarozonotriletes filatoffii
Camarozonotriletes parvus
Camarozonotriletes rugulosus
Camarozonotriletes sextantii
Camarozonotriletes sp. 1
Camarozonotriletes? *concavus*
Concentricosisporites sagittarius
Iberoespora cantabrica
Iberoespora glabella
Iberoespora cf. *I. guzmani*
?*Knoxisporites riondae*
Lophozonotriletes media
Synorisporites cf. *S. lobatus*
Synorisporites papillensis
Synorisporites verrucatus
Synorisporites spp.

Patinate spores

Amicosporites jonkeri
Amicosporites streelii
Archaeozonotriletes chulus
Archaeozonotriletes variabilis
Archaeozonotriletes spp.
Brochotriletes bellatulus
Brochotriletes foveolatus
Brochotriletes hudsonii
Brochotriletes robustus
Brochotriletes sp. 1
Chelinospora cantabrica
Chelinospora concinna
Chelinospora hemiesferica
Chelinospora cf. *hemiespherica*
Chelinospora sanpetrensis
Chelinospora timanica
Chelinospora sp. 1
Chelinospora sp. 2
Chelinospora sp. 3
Chelinospora spp.
Clivosispora verrucata var. *convoluta*
Clivosispora verrucata var. *verrucata*
Cymbosporites asymmetricus
Cymbosporites catillus
Cymbosporites cyathus
Cymbosporites dammamensis
Cymbosporites dittonensis
Cymbosporites echinatus
Cymbosporites ocularis
Cymbosporites rarispinosus
Cymbosporites senex
Cymbosporites sp. 1
Cymbosporites sp. 2
Cymbosporites sp. 3
Cymbosporites sp. 4
Cymbosporites spp.
Cyrtospora sp. 1
Dictyotriletes biornatus
Dictyotriletes favosus
Dictyotriletes sp. 1
Dictyotriletes sp. 4
Stellatispora multicostata

Zonate spores

Zonate laevigate spores

Cirratriradites diaphanus
Craspedispora sp.
Zonotriletes armillatus
Zonotriletes simplicissimus
Zonotriletes sp. 1
Zonotriletes sp. 2
Zonotriletes sp. 3
Zonotriletes sp. 4
Zonotriletes sp. 5

- *Zonotriletes* spp.

Zonate sculptured spores

- *Ancyrospora langii*
- *Ancyrospora nettersheimensis*
- *Craspedispora ghadamisensis*
- *Densosporites devonicus*
- *Lycospora culpa*
- *Samarisporites angulatus*
- *Samarisporites eximius*
- *Samarisporites* sp. 1
- *Samarisporites* sp. 2
- *Samarisporites* sp. 3
- *Samarisporites* sp. 4
- *Samarisporites* spp.
- *Samarisporites triangulatus*
- *Zonotriletes* sp. 6

Cavate spores

Cavate laevigate spores

- *Alatisporites* sp. 1
- *Auroraspora macromanifesta*
- *Auroraspora minuta*
- *Geminospora punctata*
- *Leiozosterospora* cf. *L. andersonii*

Cavate sculptured spores

- *Acinosporites* sp. 1
- *Archaeoperisaccus* cf. *A. rhacodes*
- *Contagisporites optivus*
- *Cristatisporites* sp. 1
- *Cristatisporites* sp. 2
- *Geminospora lemurata*
- *Geminospora libyensis*
- *Geminospora svalbardiae*
- *Geminospora* sp. 1
- *Geminospora* sp. 2
- *Geminospora* spp.
- *Grandispora cassidea*
- *Grandispora douglastownense*
- *Grandispora fibrilabrata*
- *Grandispora gabesensis*
- *Grandispora incognita*
- *Grandispora inculta*
- *Grandispora libyensis*
- *Grandispora* ?*naumovii*
- *Grandispora permulta*
- *Grandispora protea*
- *Grandispora rarispinosa*
- *Grandispora stolidotus*
- *Grandispora velata*
- *Grandispora* sp. 1
- *Grandispora* spp.
- *Perotrilites caperatus*
- *Rhabdosporites langii*

Rhabdosporites minutus
Rhabdosporites streelii

Two-layered cavate spores

Alatisporites sp. 1
Ancyrospora langii
Ancyrospora nettersheimensis
Archaeoperisaccus cf. *A. rhacodes*
Auroraspora macromanifesta
Auroraspora minuta
Contagisporites optivus
Cristatisporites sp. 1
Cristatisporites sp. 2
Geminospora lemurata
Geminospora libyensis
Geminospora punctata
Geminospora svalbardiae
Geminospora sp. 1
Geminospora sp. 2
Geminospora spp.
Grandispora cassidea
Grandispora douglastownense
Grandispora fibrilabrata
Grandispora gabesensis
Grandispora incognita
Grandispora inculta
Grandispora libyensis
Grandispora ?*naumovii*
Grandispora permulta
Grandispora protea
Grandispora rarispinosa
Grandispora stolidotus
Grandispora velata
Grandispora spp.
Leiozosterospora cf. *L. andersonii*
Perotrilites caperatus
Rhabdosporites langii
Rhabdosporites minutus

Three-layered cavate spores

Acinosporites sp. 1
Grandispora sp. 1
Rhabdosporites streelii

Appendix 2.1. List of species encountered in borehole BAQA-1.

Ambitisporites avitus
Ambitisporites eslae
Amicosporites streelii
Aneurospora cf. *A. bollandensis*
Apiculiretusispora brandtii
Apiculiretusispora densa
Apiculiretusispora plicata
Apiculiretusispora spp.
Archaeozonotriletes spp.
Artemopyra inconspicua
Artemopyra recticosta
Biornatispora dubia
Brochotriletes foveolatus
Brochotriletes hudsonii
Camarozonotriletes filatoffii
Chelinospora cantabrica
Chelinospora cf. *hemiespherica*
Chelinospora hemiesferica
Chelinospora sp. 1
Chelinospora sp. 2
Chelinospora spp.
Cirratriradites diaphanus
Clivosispora verrucata var. *convoluta*
Clivosispora verrucata var. *verrucata*
Concentricosisporites sagittarius
Cymbohilates baqaensis
Cymbohilates comptulus
Cymbosporites dammamensis
Cymbosporites dittonensis
Cymbosporites echinatus
Cymbosporites rarispinosus
Cymbosporites senex
Cymbosporites sp. 1
Cymbosporites sp. 2
Cymbosporites sp. 3
Cymbosporites spp.
Devonomonoletes sp. 1
Diaphanospora sp. 1
Dibolisporites bullatus
Dibolisporites eifeliensis
Dibolisporites sp. 3
Dibolisporites spp.
Dictyotriletes biornatus
Dictyotriletes emsiensis
Dictyotriletes ?*gorgoneus*
Dictyotriletes subgranifer
Dictyotriletes sp. 1
Dictyotriletes sp. 4
Dictyotriletes spp.
Emphanisporites cf. *E. edwardsiae*
Emphanisporites mcgregorii
Emphanisporites rotatus
Emphanisporites schultzii
Gneudnaspora divellomedia var. *divellomedia*
Gneudnaspora divellomedia var. *minor*

Iberoespora glabella
?*Knoxisporites riondae*
Latosporites ovalis
Lycospora culpa
Raistrickia sp. 2
Reticuloidosporites antarcticus
Retusotriletes maculatus
Retusotriletes rotundus
Retusotriletes tenerimedium
Retusotriletes triangulatus
Retusotriletes spp.
Scylaspora costulosa
Synorisporites papillensis
Verrucosisporites polygonalis
Verrucosisporites sp. 2
Verrucosisporites sp. 3
Verrucosisporites sp. 4
Verrucosisporites spp.
Zonotriletes sp. 1
Zonotriletes sp. 2
Zonotriletes sp. 6
Zonotriletes spp.

Appendix 2.2. List of species encountered in borehole BAQA-2.

Ambitisporites avitus
Amicosporites streelii
Amicosporites spp.
Apiculiretusispora plicata
Apiculiretusispora spp.
Archaeozonotriletes spp.
Biornatispora dubia
Biornatispora sp. 1
Biornatispora spp.
Brochotriletes foveolatus
Camarozonotriletes filatoffii
Chelinospora cantabrica
Chelinospora hemiesferica
Chelinospora cf. *hemiespherica*
Chelinospora sp. 1
Chelinospora sp. 2
Chelinospora spp.
Cirratriradites diaphanus
Clivosispora verrucata var. *convoluta*
Clivosispora verrucata var. *verrucata*
Concentricosisporites sagittarius
Cymbohilates baqaensis
Cymbohilates comptulus
Cymbohilates cymosus
Cymbosporites dammamensis
Cymbosporites rarispinosus
Cymbosporites senex
Cymbosporites sp. 1
Cymbosporites sp. 3
Cymbosporites spp.
Devonomonoletes sp. 1
Dibolisporites eifeliensis
Dibolisporites sp. 2
Dibolisporites sp. 3
Dibolisporites sp. 4
Dibolisporites spp.
Dictyotriletes biornatus
Dictyotriletes emsiensis
Dictyotriletes ?*gorgoneus*
Dictyotriletes subgranifer
Dictyotriletes sp. 1
Dictyotriletes spp.
Emphanisporites mcgregorii
Emphanisporites rotatus
Gneudnaspora divellomedia var. *divellomedia*
Gneudnaspora divellomedia var. *minor*
Iberoespora glabella
?*Knoxisporites riondae*
Latosporites ovalis
Leiozosterospora cf. *L. andersonii*
Lycospora culpa
Raistrickia sp. 2
Retusotriletes maculatus
Retusotriletes triangulatus
Retusotriletes spp.

Scylaspora costulosa
Synorisporites papillensis
Verrucosisporites polygonalis
Verrucosisporites sp. 2
Verrucosisporites sp. 3
Verrucosisporites sp. 4
Verrucosisporites spp.

Appendix 2.3. List of species encountered in borehole JNDL-1.

Acinosporites acanthomammillatus
Acinosporites apiculatus
Acinosporites hirsutus
Acinosporites lindlarensis
Acinosporites sp. 1
Acinosporites spp.
Ambitisporites avitus
Amicosporites streelii
Aneurospora spp.
Apiculiretusispora brandtii
Apiculiretusispora densa
Apiculiretusispora spp.
Archaeozonotriletes chulus
Artemopyra inconspicua
Artemopyra recticosta
Auroraspora minuta
Biornatispora spp.
Brochotriletes sp. 2
Camarozonotriletes rugulosus
Camarozonotriletes sextantii
Clivosispora verrucata var. *verrucata*
Cymbohilates baqaensis
Cymbohilates heteroverrucosus
Cymbosporites asymmetricus
Cymbosporites senex
Dibolisporites echinaceus
Dibolisporites gaspiensis
Dibolisporites pilatus
Dibolisporites sp. 1
Dibolisporites spp.
Emphanisporites annulatus
Emphanisporites cf. *E. biradiatus*
Emphanisporites decoratus
Emphanisporites mcgregorii
Emphanisporites rotatus
Emphanisporites schultzii
Emphanisporites sp. 1
Geminospora libyensis
Geminospora svalbardiae
Geminospora sp. 1
Gneudnaspora divellomedia var. *divellomedia*
Gneudnaspora divellomedia var. *minor*
Grandispora douglastownense
Grandispora protea
Grandispora velata
Granulatisporites sp. 1
Latosporites ovalis
Retusotriletes cf. *R. crassus*
Retusotriletes spp.
Rhabdosporites minutus
Samarisporites eximius
Scylaspora costulosa
Squamispora arabica
Synorisporites papillensis
Verruciretusispora dubia

Verrucosisporites polygonalis
Verrucosisporites spp.
Zonotriletes armillatus
Zonotriletes simplicissimus
Zonotriletes sp. 1
Zonotriletes sp. 3
Zonotriletes sp. 4

Appendix 2.4. List of species encountered in borehole JNDL-3.

Acinosporites lindlarensis
Alatisporites sp. 1
Ambitisporites avitus
Aneurospora spp.
Apiculiretusispora brandtii
Apiculiretusispora plicata
Apiculiretusispora spp.
Archaeozonotriletes chulus
Artemopyra inconspicua
Artemopyra recticosta
Biornatispora dubia
Brochotriletes sp. 2
Camarozonotriletes sextantii
Cirratriradites diaphanus
Cymbohilates baqaensis
Cymbohilates heteroverrucosus
Cymbosporites asymmetricus
Cymbosporites dammamensis
Cymbosporites senex
Diatomozonotriletes franklinii
Dibolisporites eifeliensis
Dibolisporites spp.
Dictyotriletes biornatus
Dictyotriletes emsiensis
Dictyotriletes favosus
Dictyotriletes spp.
Dictyotriletes subgranifer
Emphanisporites erraticus
Emphanisporites mcgregorii
Emphanisporites rotatus
Emphanisporites schultzii
Gneudnaspora divellomedia var. *divellomedia*
Gneudnaspora divellomedia var. *minor*
Latosporites ovalis
Retusotriletes maculatus
Retusotriletes spp.
Rhabdosporites minutus
Scylaspora costulosa
Stellatispora multicostata
Synorisporites papillensis
Tetrahedraletes medinensis
Verrucosisporites polygonalis
Verrucosisporites sp. 2
Verrucosisporites spp.
Zonotriletes spp.

Appendix 2.5. List of species encountered in borehole JNDL-4.

Acinosporites lindlarensis
Ambitisporites avitus
Amicosporites streelii
Aneurospora spp.
Apiculiretusispora brandtii
Apiculiretusispora plicata
Apiculiretusispora spp.
Archaeozonotriletes chulus
Archaeozonotriletes spp.
Artemopyra inconspicua
Artemopyra recticosta
Biornatispora dubia
Brochotriletes foveolatus
Camarozonotriletes filatoffii
Chelinospora spp.
Cirratriradites diaphanus
Clivosispora verrucata var. *convoluta*
Clivosispora verrucata var. *verrucata*
Cymbohilates baqaensis
Cymbohilates comptulus
Cymbohilates heteroverrucosus
Cymbosporites asymmetricus
Cymbosporites dammamensis
Cymbosporites senex
Cymbosporites sp. 2
Cymbosporites sp. 3
Dibolisporites eifeliensis
Dibolisporites spp.
Dictyotriletes biornatus
Dictyotriletes emsiensis
Dictyotriletes favosus
Dictyotriletes subgranifer
Dictyotriletes spp.
Emphanisporites cf. *E. biradiatus*
Emphanisporites mcgregorii
Emphanisporites rotatus
Emphanisporites schultzii
Gneudnaspora divellomedia var. *divellomedia*
Gneudnaspora divellomedia var. *minor*
?*Knoxisporites riondae*
Latosporites ovalis
Leiozosterospora cf. *L. andersonii*
Retusotriletes maculatus
Retusotriletes rotundus
Retusotriletes triangulatus
Retusotriletes spp.
Rhabdosporites minutus
Scylaspora costulosa
Stellatispora multicostata
Synorisporites papillensis
Tetrahedraletes medinensis
Verrucosisporites polygonalis
Verrucosisporites sp. 1
Verrucosisporites spp.
Zonotriletes sp. 1

Zonotriletes sp. 6
Zonotriletes spp.

Appendix 2.6. List of species encountered in borehole S-462.

Acinosporites lindlarensis
Ancyrospora langii
Apiculiretusispora spp.
Archaeozonotriletes chulus
Archaeozonotriletes variabilis
Artemopyra recticosta
Auroraspora minuta
Brochotriletes foveolatus
Camarozonotriletes parvus
Camarozonotriletes? *concavus*
Chelinospora concinna
Chelinospora timanica
Chelinospora spp.
Contagisporites optivus
Corystisporites collaris
Craspedispora ghadamisensis
Cristatisporites sp. 1
Cristatisporites sp. 2
Cymbosporites catillus
Cymbosporites cyathus
Dibolisporites farraginis
Dibolisporites uncatus
Dibolisporites sp. 1
Dibolisporites spp.
Dictyotriletes sp. 2
Elenisporis sp. 1
Elenisporis sp. 2
Emphanisporites annulatus
Emphanisporites mcgregorii
Emphanisporites rotatus
Emphanisporites sp. 3
Geminospora lemurata
Geminospora punctata
Gneudnaspora divellomedia var. *divellomedia*
Grandispora fibrilabrata
Grandispora incognita
Grandispora inculta
Grandispora libyensis
Grandispora ?*naumovii*
Grandispora permulta
Grandispora rarispinosa
Grandispora stolidotus
Grandispora velata
Grandispora spp.
Retusotriletes triangulatus
Retusotriletes sp. 1
Retusotriletes spp.
Rhabdosporites langii
Samarisporites eximius
Samarisporites triangulatus
Samarisporites sp. 2
Samarisporites spp.
Scylaspora rugulata
Verrucisporites ellesmerensis
Verrucosisporites premnus

Verrucosisporites scurrus
Verrucosisporites spp.
Zonotriletes simplicissimus

Appendix 2.7. List of species encountered in well ABSF-29.

Acinosporites apiculatus
Acinosporites lindlarensis
Acinosporites spp.
Aneurospora spp.
Apiculiretusispora brandtii
Apiculiretusispora spp.
Archaeozonotriletes chulus
Biornatispora dubia
Brochotriletes foveolatus
Camarozonotriletes? *concavus*
Cymbohilates comptulus
Cymbosporites catillus
Cymbosporites senex
Cymbosporites spp.
Dibolisporites spp.
Dictyotriletes sp. 2
Emphanisporites annulatus
Emphanisporites mcgregorii
Emphanisporites rotatus
Geminospora lemurata
Geminospora punctata
Gneudnaspora divellomedia var. *divellomedia*
Grandispora douglastownense
Grandispora gabesensis
Grandispora permulta
Grandispora stolidotus
Grandispora spp.
Latosporites ovalis
Retusotriletes tenerimedium
Retusotriletes triangulatus
Retusotriletes spp.
Rhabdosporites langii
Samarisporites eximius
Samarisporites triangulatus
Scylaspora rugulata
Synorisporites papillensis
Verrucosisporites premnus
Verrucosisporites scurrus
Zonotriletes spp.

Appendix 2.8. List of species encountered in well FWRH-1.

Ambitisporites eslae
Amicosporites streelii
Apiculiretusispora spp.
Archaeozonotriletes chulus
Archaeozonotriltes spp.
Artemopyra recticosta
Biornatispora dubia
Brochotriletes bellatulus
Brochotriletes foveolatus
Camarozonotriletes filatoffii
Cirratriradites diaphanus
Clivosispora verrucata var. *convoluta*
Clivosispora verrucata var. *verrucata*
Cymbosporites dammamensis
Cymbosporites dittonensis
Cymbosporites senex
Diaphanospora sp. 1
Dibolisporites eifeliensis
Dibolisporites spp.
Dictyotriletes emsiensis
Emphanisporites rotatus
Gneudnaspora divellomedia var. *divellomedia*
Latosporites ovalis
Retusotriletes maculatus
Retusotriletes tenerimedium
Retusotriletes triangulatus
Retusotriletes sp. 2
Retusotriletes spp.
Scylaspora costulosa
Synorisporites papillensis
Tetrahedraletes medinensis
Verrucosisporites polygonalis

Appendix 2.9. List of species encountered in well HWYH-956.

Acinosporites apiculatus
Acinosporites lindlarensis
Ambitisporites asturicus
Ambitisporites avitus
Amicosporites streelii
Aneurospora spp.
Apiculiretusispora brandtii
Apiculiretusispora plicata
Apiculiretusispora spp.
Archaeozonotriletes chulus
Artemopyra recticosta
Biornatispora dubia
Biornatispora spp.
Brochotriletes foveolatus
Brochotriletes robustus
Camarozonotriletes filatoffii
Chelinospora cf. *hemiespherica*
Cirratriradites diaphanus
Clivosispora verrucata var. *verrucata*
Cymbohilates baqaensis
Cymbohilates comptulus
Cymbosporites asymmetricus
Cymbosporites dammamensis
Cymbosporites senex
Dibolisporites eifeliensis
Dibolisporites gaspiensis
Dibolisporites spp.
Dictyotriletes emsiensis
Dyadospora murusattenuata
Emphanisporites rotatus
Emphanisporites schultzii
Gneudnaspora divellomedia var. *divellomedia*
Gneudnaspora divellomedia var. *minor*
?*Knoxisporites riondae*
Latosporites ovalis
Retusotriletes goensis
Retusotriletes maculatus
Retusotriletes rotundus
Retusotriletes tenerimedium
Retusotriletes triangulatus
Retusotriletes sp. 2
Retusotriletes spp.
Scylaspora costulosa
Synorisporites papillensis
Tetrahedraletes medinensis
Verrucosisporites polygonalis
Verrucosisporites spp.
Zonotriletes spp.

Appendix 2.10. List of species encountered in well KHRM-2.

Acinosporites lindlarensis
Ambitisporites avitus
Amicosporites streelii
Aneurospora spp.
Apiculiretusispora brandtii
Apiculiretusispora densa
Apiculiretusispora spp.
Archaeozonotriletes chulus
Artemopyra recticosta
Biornatispora dubia
Brochotriletes bellatulus
Brochotriletes foveolatus
Camarozonotriletes filatoffii
Camarozonotriletes sextantii
Chelinospora spp.
Cirratriradites diaphanus
Clivosispora verrucata var. *verrucata*
Cymbohilates baqaensis
Cymbohilates comptulus
Cymbosporites dammamensis
Cymbosporites rarispinosus
Cymbosporites senex
Cymbosporites sp. 1
Diaphanospora sp. 1
Dibolisporites eifeliensis
Dibolisporites spp.
Dictyotriletes emsiensis
Dictyotriletes ?*gorgoneus*
Dictyotriletes favosus
Dictyotriletes spp.
Dyadospora murusattenuata
Emphanisporites decoratus
Emphanisporites mcgregorii
Emphanisporites rotatus
Emphanisporites schultzii
Gneudnaspora divellomedia var. *divellomedia*
Gneudnaspora divellomedia var. *minor*
Iberoespora cf. *I. guzmani*
Latosporites ovalis
Raistrickia sp. 2
Retusotriletes cf. *R. crassus*
Retusotriletes maculatus
Retusotriletes rotundus
Retusotriletes triangulatus
Retusotriletes spp.
Rhabdosporites minutus
Scylaspora costulosa
Stellatispora multicostata
Synorisporites papillensis
Tetrahedraletes medinensis
Verrucosisporites polygonalis
Verrucosisporites sp. 1
Verrucosisporites sp. 2
Zonotriletes spp.

Appendix 2.11. List of species encountered in well NFLA-1.

Apiculiretusispora spp.
Biornatispora dubia (McGregor) Steemans, 1989
Cirratriradites diaphanus Steemans, 1989
Clivosispora verrucata var. *verrucata* McGregor, 1973
Cymbosporites asymmetricus Breuer et al., 2007
Cymbosporites senex McGregor & Camfield, 1976
Dibolisporites eifeliensis (Lanninger) McGregor, 1973
Dibolisporites spp.
Emphanisporites rotatus Mcgregor emend. McGregor, 1973
Gneudnaspora divellomedia var. *divellomedia* (Tchibrikova) Balme, 1988
Gneudnaspora divellomedia (Tchibrikova) Balme, 1988 var. *minor* Breuer et al., 2007
Latosporites ovalis Breuer et al., 2007
Leiozosterospora cf. *L. andersonii* Wellman, 2006
Retusotriletes tenerimedium Tchibrikova, 1959
Retusotriletes triangulatus (Streel) Streel, 1967
Retusotriletes spp.

Appendix 2.12. List of species encountered in well SDGM-462.

Acinosporites apiculatus
Acinosporites lindlarensis
Aneurospora spp.
Apiculiretusispora brandtii
Apiculiretusispora spp.
Archaeozonotriletes chulus
Biornatispora dubia
Brochotriletes foveolatus
Camarozonotriletes sextantii
Chelinospora spp.
Cirratriradites diaphanus
Clivosispora verrucata var. *verrucata*
Cymbohilates baqaensis
Cymbohilates comptulus
Cymbosporites asymmetricus
Cymbosporites senex
Dibolisporites eifeliensis
Dibolisporites spp.
Dictyotriletes spp.
Emphanisporites rotatus
Gneudnaspora divellomedia var. *divellomedia*
Gneudnaspora divellomedia var. *minor*
?*Knoxisporites riondae*
Latosporites ovalis
Retusotriletes tenerimedium
Retusotriletes triangulatus
Retusotriletes spp.
Scylaspora costulosa
Verrucosisporites polygonalis

Appendix 2.13. List of species encountered in well UTMN-1830.

Acinosporites lindlarensis
Ambitisporites avitus
Amicosporites streelii
Aneurospora cf. *A. bollandensis*
Aneurospora spp.
Apiculiretusispora brandtii
Apiculiretusispora spp.
Archaeozonotriletes chulus
Artemopyra recticosta
Biornatispora dubia
Brochotriletes foveolatus
Camarozonotriletes filatoffii
Camarozonotriletes sextantii
Chelinospora cantabrica
Chelinospora spp.
Cirratriradites diaphanus
Clivosispora verrucata
Clivosispora verrucata var. *verrucata*
Concentricosisporites sagittarius
Cymbohilates baqaensis
Cymbohilates comptulus
Cymbohilates heteroverrucosus
Cymbosporites asymmetricus
Cymbosporites dammamensis
Cymbosporites dittonensis
Cymbosporites senex
Diaphanospora sp. 1
Dibolisporites bullatus
Dibolisporites eifeliensis
Dibolisporites spp.
Dictyotriletes biornatus
Dictyotriletes emsiensis
Dictyotriletes favosus
Dictyotriletes spp.
Emphanisporites rotatus
Emphanisporites schultzii
Gneudnaspora divellomedia var. *divellomedia*
Gneudnaspora divellomedia var. *minor*
Iberoespora cf. *I. guzmani*
Latosporites ovalis
Retusotriletes cf. *R. crassus*
Retusotriletes maculatus
Retusotriletes rotundus
Retusotriletes tenerimedium
Retusotriletes triangulatus
Retusotriletes sp. 2
Retusotriletes spp.
Scylaspora costulosa
Stellatispora multicostata
Synorisporites papillensis
Tetrahedraletes medinensis
Verruciretusispora dubia
Verrucosisporites polygonalis
Verrucosisporites spp.
Zonotriletes sp. 1

Appendix 2.14. List of species encountered in well YBRN-1.

Acinosporites lindlarensis
Apiculiretusispora spp.
Archaeozonotriletes variabilis
Artemopyra recticosta
Auroraspora minuta
Brochotriletes bellatulus
Brochotriletes robustus
Camarozonotriletes parvus
Camarozonotriletes? *concavus*
Corystisporites undulatus
Cristatisporites sp. 1
Cymbosporites catillus
Cymbosporites cyathus
Dibolisporites uncatus
Dibolisporites spp.
Dictyotriletes sp. 2
Emphanisporites annulatus
Emphanisporites mcgregorii
Emphanisporites rotatus
Emphanisporites schultzii
Geminospora lemurata
Geminospora punctata
Gneudnaspora divellomedia var. *divellomedia*
Grandispora incognita
Grandispora permulta
Grandispora spp.
Retusotriletes cf. *R. crassus* Clayton
Retusotriletes goensis
Retusotriletes rotundus
Retusotriletes triangulatus
Retusotriletes spp.
Rhabdosporites langii
Samarisporites triangulatus
Scylaspora rugulata
Verrucisporites ellesmerensis
Verrucosisporites scurrus

Appendix 3.1. List of species encountered in borehole A1-69.

Acinosporites acanthomammillatus
Acinosporites apiculatus
Acinosporites lindlarensis
Acinosporites spp.
Ambitisporites avitus
Amicosporites jonkeri
Ancyrospora langii
Ancyrospora nettersheimensis
Apiculiretusispora brandtii
Apiculiretusispora spp.
Archaeozonotriletes chulus
Archaeozonotriletes variabilis
Artemopyra inconspicua
Artemopyra recticosta
Auroraspora minuta
Biornatispora dubia
Brochotriletes foveolatus
Brochotriletes hudsonii
Brochotriletes sp. 1
Brochotriletes sp. 2
Camarozonotriletes parvus
Camarozonotriletes rugulosus
Camarozonotriletes sextantii
Camarozonotriletes sp. 1
Camarozonotriletes? *concavus*
Chelinospora concinna
Chelinospora sp. 3
Chelinospora spp.
Chelinospora timanica
Clivosispora verrucata var. *convoluta*
Contagisporites optivus
Corystisporites collaris
Corystisporites multispinosus
Corystisporites undulatus
Craspedispora ghadamisensis
Craspedispora sp.
Cristatisporites sp. 1
Cymbosporites asymmetricus
Cymbosporites catillus
Cymbosporites cyathus
Cymbosporites sp. 4
Cymbosporites spp.
Cyrtospora sp. 1
Diaphanospora sp. 1
Diatomozonotriletes franklinii
Dibolisporites echinaceus
Dibolisporites eifeliensis
Dibolisporites farraginis
Dibolisporites gaspiensis
Dibolisporites turriculatus
Dibolisporites uncatus
Dibolisporites sp. 1
Dibolisporites sp. 5
Dibolisporites spp.
Dictyotriletes emsiensis

Dictyotriletes favosus
Dictyotriletes subgranifer
Dictyotriletes spp.
Emphanisporites annulatus
Emphanisporites mcgregorii
Emphanisporites rotatus
Emphanisporites sp. 2
Geminospora lemurata
Geminospora libyensis
Geminospora punctata
Geminospora svalbardiae
Geminospora sp. 1
Geminospora sp. 2
Gneudnaspora divellomedia var. *divellomedia*
Gneudnaspora divellomedia var. *minor*
Grandispora ?naumovii
Grandispora douglastownense
Grandispora fibrilabrata
Grandispora gabesensis
Grandispora incognita
Grandispora inculta
Grandispora libyensis
Grandispora permulta
Grandispora protea
Grandispora stolidotus
Grandispora velata
Grandispora sp. 1
Grandispora spp.
Granulatisporites sp. 1
Jhariatriletes emsiensis
Latosporites ovalis
Lophotriletes devonicus
Lophozonotriletes media
Raistrickia sp. 1
Retusotriletes maculatus
Retusotriletes rotundus
Retusotriletes tenerimedium
Retusotriletes triangulatus
Retusotriletes sp. 1
Retusotriletes sp. 2
Retusotriletes spp.
Rhabdosporites langii
Rhabdosporites minutus
Rhabdosporites streelii
Samarisporites angulatus
Samarisporites eximius
Samarisporites triangulatus
Samarisporites sp. 2
Samarisporites sp. 3
Samarisporites sp. 4
Scylaspora rugulata
Synorisporites papillensis
Synorisporites verrucatus
Verrucosisporites polygonalis
Verrucosisporites premnus
Verrucosisporites scurrus

Verrucosisporites sp. 2
Verrucosisporites spp.
Zonotriletes simplicissimus
Zonotriletes sp. 1
Zonotriletes sp. 3
Zonotriletes sp. 4
Zonotriletes sp. 5
Zonotriletes spp.

Appendix 3.2. Table of conversion between samples from borehole MG-1 expressed in meter and feet.

m	ft
2160.6	7088.58
2161.8	7092.52
2178.0	7145.67
2180.0	7152.23
2181.2	7156.17
2182.4	7160.10
2194.0	7198.16
2205.0	7234.25
2212.5	7258.86
2222.7	7292.32
2241.0	7352.36
2247.0	7372.05
2252.1	7388.78
2258.0	7408.14
2264.0	7427.82
2270.0	7447.51
2278.0	7473.75
2280.3	7481.30
2285.0	7496.72
2292.0	7519.69
2295.0	7529.53
2300.0	7545.93
2304.0	7559.06
2314.0	7591.86
2315.0	7595.14
2317.0	7601.71
2367.0	7765.75
2375.0	7791.99
2405.0	7890.42
2413.0	7916.67
2416.8	7929.13
2421.0	7942.91
2435.0	7988.85
2448.0	8031.50
2450.6	8040.03
2456.0	8057.74
2465.0	8087.27
2476.0	8123.36
2483.0	8146.33
2511.0	8238.19
2518.0	8261.16
2520.0	8267.72
2527.0	8290.68
2536.0	8320.21
2543.0	8343.18
2557.5	8390.75
2606.0	8549.87
2631.2	8632.55
2639.0	8658.14
2678.0	8786.09
2693.0	8835.30
2704.0	8871.39
2713.0	8900.92
2728.0	8950.13
2741.4	8994.09

Appendix 3.3. List of species encountered in borehole MG-1.

Acinosporites acanthomammillatus
Acinosporites apiculatus
Acinosporites eumammillatus
Acinosporites lindlarensis
Acinosporites spp.
Alatisporites sp. 1
Ambitisporites asturicus
Ambitisporites avitus
Amicosporites jonkeri
Amicosporites streelii
Ancyrospora langii
Apiculiretusispora brandtii
Apiculiretusispora spp.
Archaeoperisaccus cf. *rhacodes*
Archaeozonotriletes chulus
Archaeozonotriletes variabilis
Artemopyra inconspicua
Artemopyra recticosta
Auroraspora macromanifesta
Auroraspora minuta
Biornatispora dubia
Biornatispora spp.
Brochotriletes foveolatus
Brochotriletes hudsonii
Camarozonotriletes parvus
Camarozonotriletes sextantii
Camarozonotriletes sp. 1
Camarozonotriletes? *concavus*
Chelinospora concinna
Chelinospora sanpetrensis
Chelinospora timanica
Cirratriradites diaphanus
Concentricosisporites sagittarius
Convolutispora subtilis
Corystisporites undulatus
Craspedispora ghadamisensis
Cristatisporites sp. 1
Cristatisporites sp. 2
Cymbohilates baqaensis
Cymbohilates sp. 1
Cymbosporites asymmetricus
Cymbosporites catillus
Cymbosporites cyathus
Cymbosporites dammamensis
Cymbosporites dittonensis
Cymbosporites ocularis
Cymbosporites sp. 4
Cymbosporites spp.
Cyrtospora sp. 1
Densosporites devonicus
Diatomozonotriletes franklinii
Dibolisporites eifeliensis
Dibolisporites farraginis
Dibolisporites gaspiensis
Dibolisporites turriculatus

Dibolisporites uncatus
Dibolisporites sp. 1
Dibolisporites spp.
Dictyotriletes emsiensis
Dictyotriletes subgranifer
Dictyotriletes sp. 3
Dictyotriletes spp.
Elenisporis sp. 1
Elenisporis sp. 2
Emphanisporites annulatus
Emphanisporites decoratus
Emphanisporites mcgregorii
Emphanisporites rotatus
Emphanisporites schultzii
Emphanisporites sp. 2
Emphanisporites sp. 3
Geminospora lemurata
Geminospora libyensis
Geminospora punctata
Geminospora svalbardiae
Geminospora spp.
Gneudnaspora divellomedia var. *divellomedia*
Gneudnaspora divellomedia var. *minor*
Grandispora cassidea
Grandispora douglastownense
Grandispora gabesensis
Grandispora incognita
Grandispora libyensis
Grandispora permulta
Grandispora protea
Grandispora rarispinosa
Grandispora stolidotus
Grandispora velata
Grandispora sp. 1
Grandispora spp.
Hystricosporites sp. 1
Hystricosporites sp. 2
Iberoespora cantabrica
?*Knoxisporites riondae*
Latosporites ovalis
Latosporites sp. 1
Lophozonotriletes media
Lycospora culpa
Perotrilites caperatus
Raistrickia sp. 1
Retusotriletes maculatus
Retusotriletes rotundus
Retusotriletes tenerimedium
Retusotriletes triangulatus
Retusotriletes sp. 1
Retusotriletes spp.
Rhabdosporites langii
Rhabdosporites minutus
Samarisporites angulatus
Samarisporites eximius
Samarisporites triangulatus

Samarisporites sp. 1
Samarisporites sp. 2
Samarisporites sp. 3
Scylaspora rugulata
Scylaspora cf. *S. scripta*
Synorisporites cf. *S. lobatus*
Synorisporites papillensis
Synorisporites verrucatus
Verrucosisporites polygonalis
Verrucosisporites premnus
Verrucosisporites scurrus
Verrucosisporites spp.
Zonotriletes armillatus
Zonotriletes sp. 1
Zonotriletes sp. 2
Zonotriletes sp. 4
Zonotriletes spp.