

The Impact of CA-IDTIMS on the Understanding of Permian and Triassic Lithostratigraphy and Correlation in Eastern Australian Coal Basins*

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Abstract

In recent years, numerous correlations of the Permian and Triassic successions in the eastern Australian coal basins (Sydney, Gunnedah, Bowen and Galilee basins) have been attempted based on broad scale lithostratigraphy, sequence stratigraphy and biostratigraphy. However, detailed correlation of these successions has proved difficult. The development of Chemical Abrasion-Isotope Dilution Thermal Ionisation Mass Spectrometry (CA-IDTIMS), with its dramatically increased precision, has allowed more precise correlations to be obtained. This is in part because of the large number of tuffs in these eastern Australian basins, which range from the lowest Permian to the middle Triassic and number in the several hundred. The new correlations have resulted in numerous revisions to the ages of important units in eastern Australian basins. For example, the uppermost coal successions in the Sydney Basin (Newcastle Coal Measures, Illawarra Coal Measures) extend to very near the Permian-Triassic boundary and have a shorter duration than previously thought. The underlying Tomago Coal Measures/Whittingham Coal measures, rather than extending from the basal Wordian to earliest Wuchiapingian extend from the middle Capitanian to middle Wuchiapingian. Similarly, the top of the Greta Coal Measures, rather than being middle Kungurian are now known to be middle

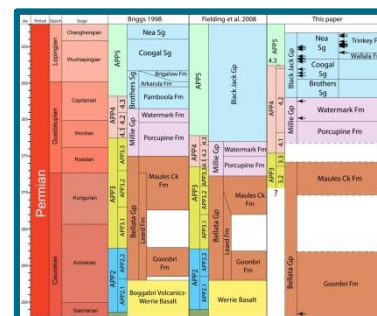
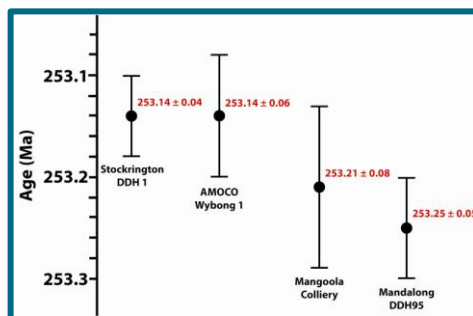
Roadian. In the Gunnedah Basin, the top of the Millie Group was basal Wordian, but is now considered middle Capitanian, while the overlying Brothers Subgroup, which was thought to extend up to the middle Capitanian is now known to be middle Wuchiapingian. The overlying Coogal Subgroup has been dramatically shortened in duration, and now lies entirely within the middle Wuchiapingian. In the Bowen Basin, the changes are similar, with the base of the Peawaddy Formation changed to late Wuchiapingian rather than middle Wordian, the base of the overlying Black Alley Formation now being latest Wuchiapingian rather than late Capitanian, and the base of the Bandanna Formation reassigned to earliest Changhsingian, rather than early Wuchiapingian. This recalibration of stratigraphy allows for a much improved understanding of basin history and the correlations between stratigraphic units, within and between eastern Australian basins.

Reference Cited

Price, P.L., 1997, Permian to Jurassic palynostratigraphic nomenclature of the Bowen and Surat basins, *in* P. Green, ed., The Surat and Bowen Basins, southeast Queenslan, Queensland. Department of Mines and Energy, Brisbane, p. 137-178.



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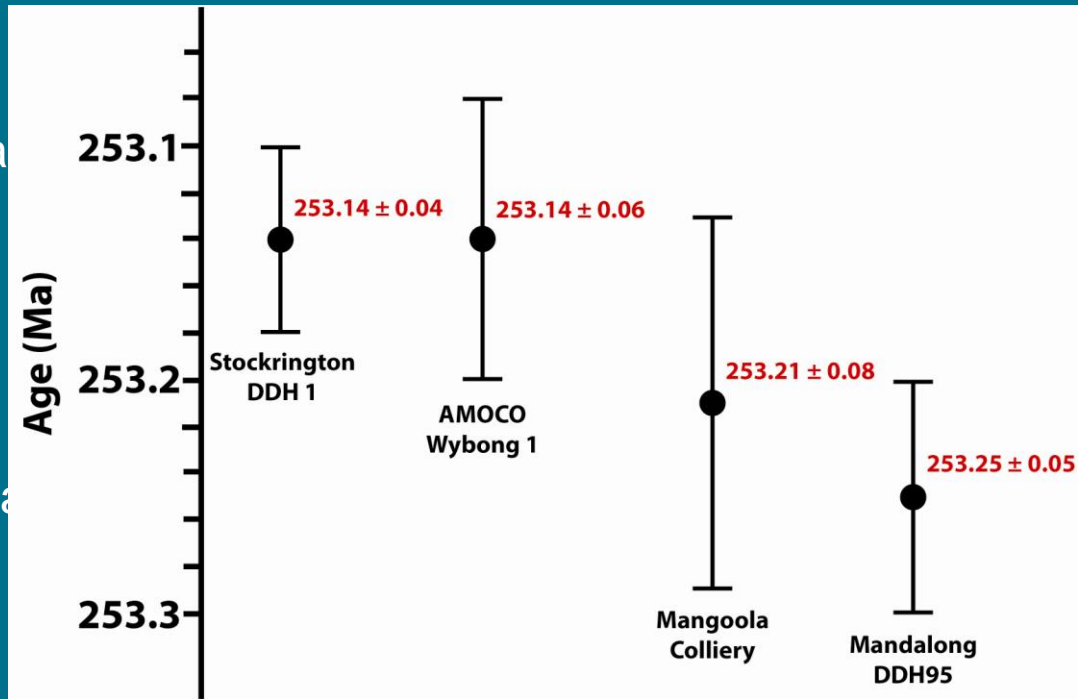


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CA-IDTIMS

Chemical Ablation Isotope Dilution Thermal Ionisation Mass Spectrometry

- Zircon crystals from volcanic and metamorphic rocks
- Radiometric U-Pb dating
- High precision (e.g. ± 100 ky)
- Some Limitations
 - Dwell time of zircons in mass spectrometer



CA-IDTIMS

- Multiple applications
 - regional & international correlation
 - timing of tectonic events
 - tying tuff beds to their volcanic source
 - depositional rates
- Best results obtained with a sequence of dates

The technique be used throughout the stratigraphic column, give us an ash bed with zircons, we can probably date it!

Volcanic eruptions

Plinian eruptions create extensive ash beds, providing a time horizon across a broad area



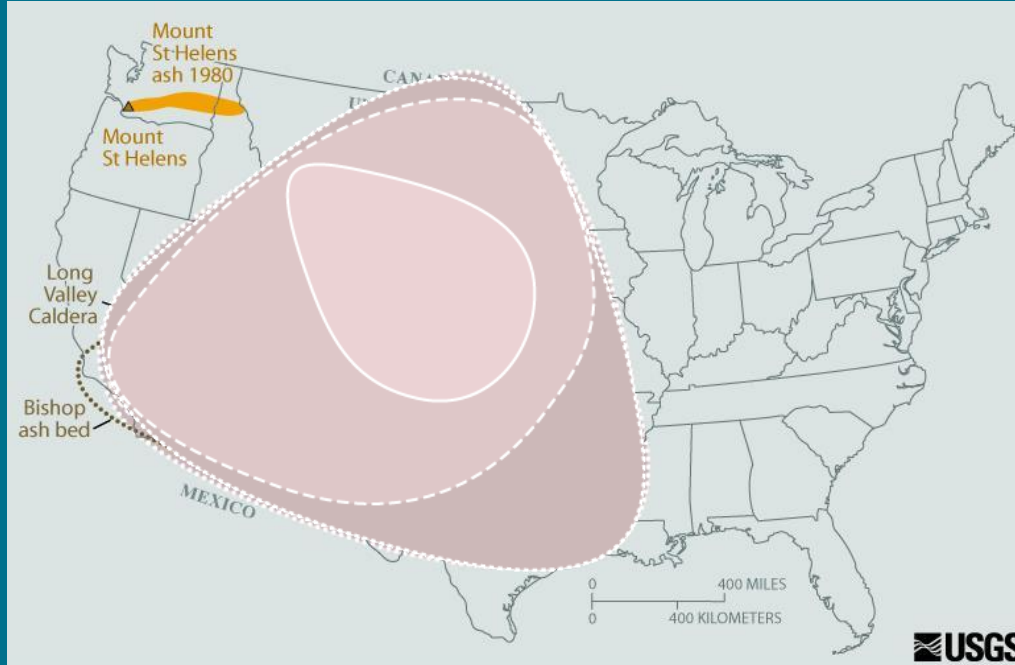
Tuffs in coals

Volcanic ash deposits over peat swamps create distinctive geological layers



These types of layers are abundant in the Eastern Australian coal basins

Extent of Yellowstone eruptions relative to Eastern Australia



http://volcanoes.usgs.gov/volcanoes/yellowstone/yellowstone_sub_page_91.html

Tying tuff beds to their volcanic source



Numerous Tuffs around the same age:

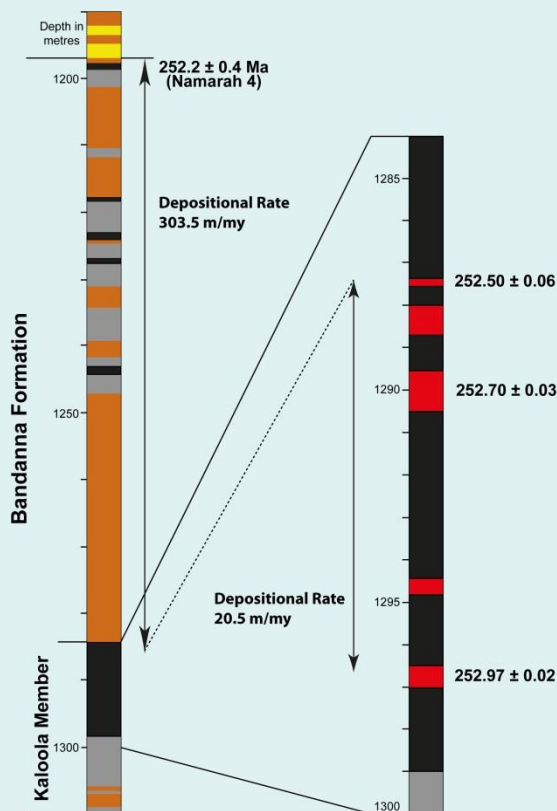
- Trinkey Formation - 254.57
- Trinkey Formation - 254.65
- Trinkey Formation - 254.67
- Wybong 1 - 254.82
- Huntley Claystone - 254.86
- Trinkey Formation - 254.87
- Nobby's Tuff - 254.88



Wandsworth volcanics:

- 254.66 ± 0.14 (at Attunga Creek)
- 254.85 ± 0.28

YEBNA 1, BOWEN BASIN



Depositional rates

Yebna 1, Bowen Basin

Bandanna Formation including
Kaloola Member

Depositional rate of Kaloola
Member 20.5 m/my

Depositional rate of remainder of
Bandanna Formation 303.5 m/my

Price et al. 1997 biozones

After Price et al. 1997

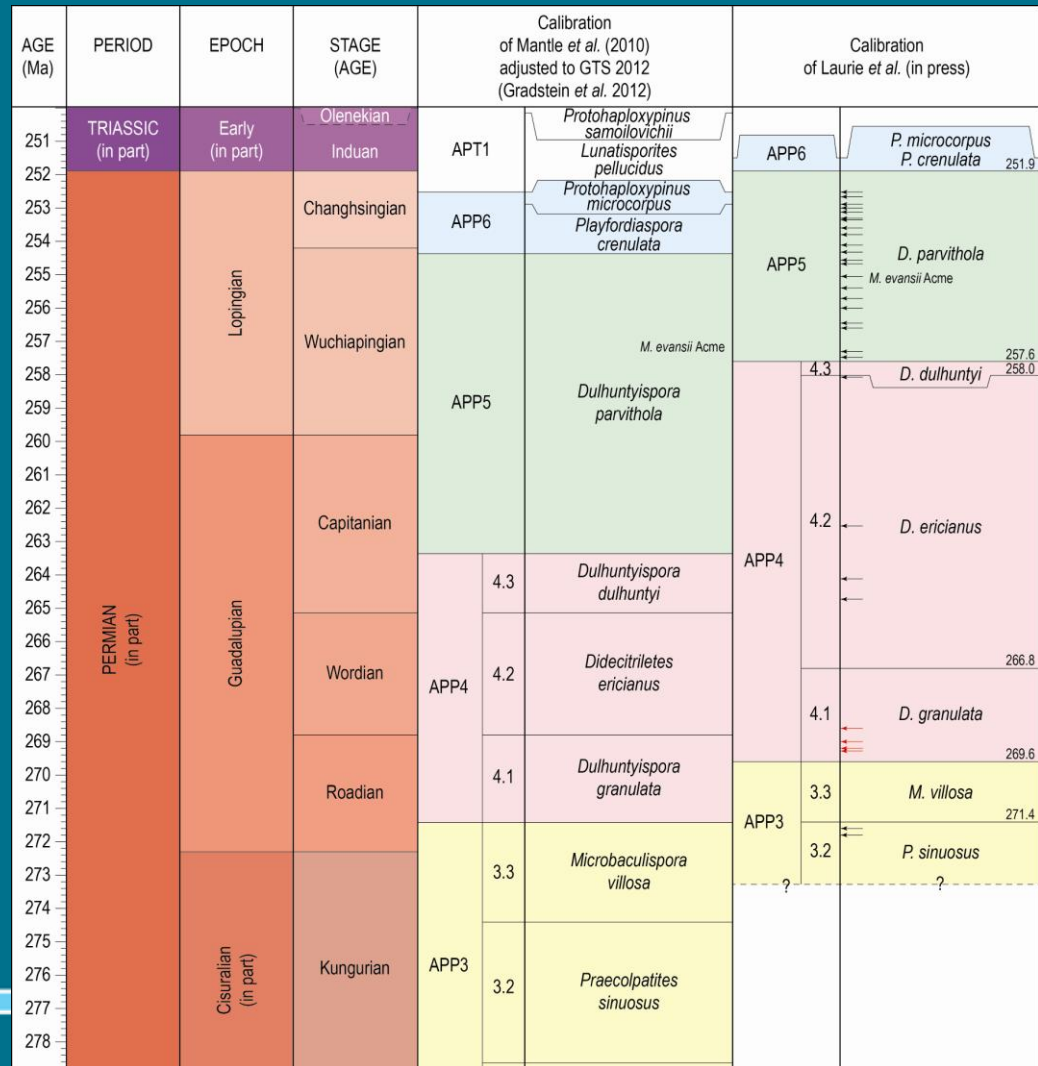
Period	Pre-1985 usage	1990 nomenclature (Filatoff and Price, 1990; Draper and others, 1990)			Current nomenclature (Filatoff and Price, 1991; Price, 1994)			Index forms
Triassic	Tr1b	APT1			APT1			<i>Lunatisporites pellucidus</i> (sp.92)
	Tr1a	APP6			APP6			<i>Triplexisporites playfordii</i> (sp. 805)
							5006	<i>Lycopodiumsporites "crassus"</i> (sp. 1083)
							5005	<i>Microhystridium evansii</i> Acme Zone ('P3c horizon')
	Upper stage 5	APP5	5.0.3		APP5		5004	<i>Microreticulatisporites bitriangularis "bireticularis"</i> (sp. 1079)
							5003	<i>Dulhuntyispora stellata radians</i> (sp. 312)
	U5a		5.0.2	5.0.2.2			5002	<i>Dulhuntyispora spongia</i> (sp. 277 and 309)
			5.0.1	5.0.1.1			5001	<i>Dulhuntyispora (large forms)</i> (sp. 1141, 313 and 308)
								<i>Dulhuntyispora parvitholus</i> (sp. 339)
	Lower stage 5	L5c	4.3		APP4	43	432	<i>Dulhuntyispora sp. cf. D. parvitholus</i> (sp. 298)
Late Permian	L5b	APP4	4.2		APP4	42		<i>Dulhuntyispora dulhuntyi</i> (sp. 6)
	L5a		4.1			41		<i>Didecitriletes ericianus</i> (sp. 7)
								<i>Dulhuntyispora granulata</i>
							3322	<i>Lopadospira vermithola</i> (sp. 205)
	U4b		3.3	3.3.2		33	332	<i>Lopadospira pannosus</i> (sp.1379)
				3.3.1			331	<i>Acanthotriletes villosus</i> (sp. 5)
							322	<i>Acanthotriletes "baculatus"</i> (sp. 251)
	Stage 4	APP3	3.2		APP3	32	321	<i>Granulatisporites sp. ct. M. Indica</i> (sp.4)
	U4a						3212	<i>Propinquispora praetholus</i> (sp. 206)
							3211	<i>Granulatisporites trisinus "subtilis"</i> (sp. 3781)
							3102	<i>Praecolpatites sinuosus "corona"</i> (sp. 21)
	L4		3.1			31	3101	<i>Granulatisporites trisinus "microsubtilis"</i> (sp. 4549)
							2222	<i>Phaselisporites cicatricosus</i> (sp. 63)
	3b	APP2	2.2		APP2	22	222	<i>Granulatisporites "parvus"</i> (sp. 4610)
							221	<i>Gondisporites ewingtonensis</i> (sp. 4569)
	3a		2.1			21	212	<i>Granulatisporites trisinus</i> (sp.671)
							211	<i>Striatopodocarpites fusus</i> (sp. 1181)
	Stage 3						122	<i>Pseudoreticulatispora pseudoreticulata</i> (sp. 1595)
Early Permian		APP1	1.2		APP1	12	121	<i>Pseudoreticulatispora confluens</i> (sp. 194)
	Stage 2						1212	<i>Granulatisporites micronodosus</i> (sp. 46)
							1211	<i>Granulatisporites tentula</i> (sp. 276)
			1.1			11		<i>Protophloxypinus</i> spp.
			4.2			42		<i>Diatomozonotrites birkheadensis</i> (sp. 1612)
	Stage 1	APL4	4.1		APL4	41		<i>Pontonieisporites</i> spp.
Late Carboniferous								

NOTE: * APP4 forms, including *A. villosus*, *P. cicatricosus*

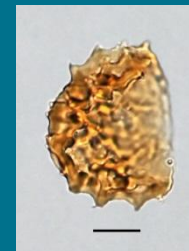
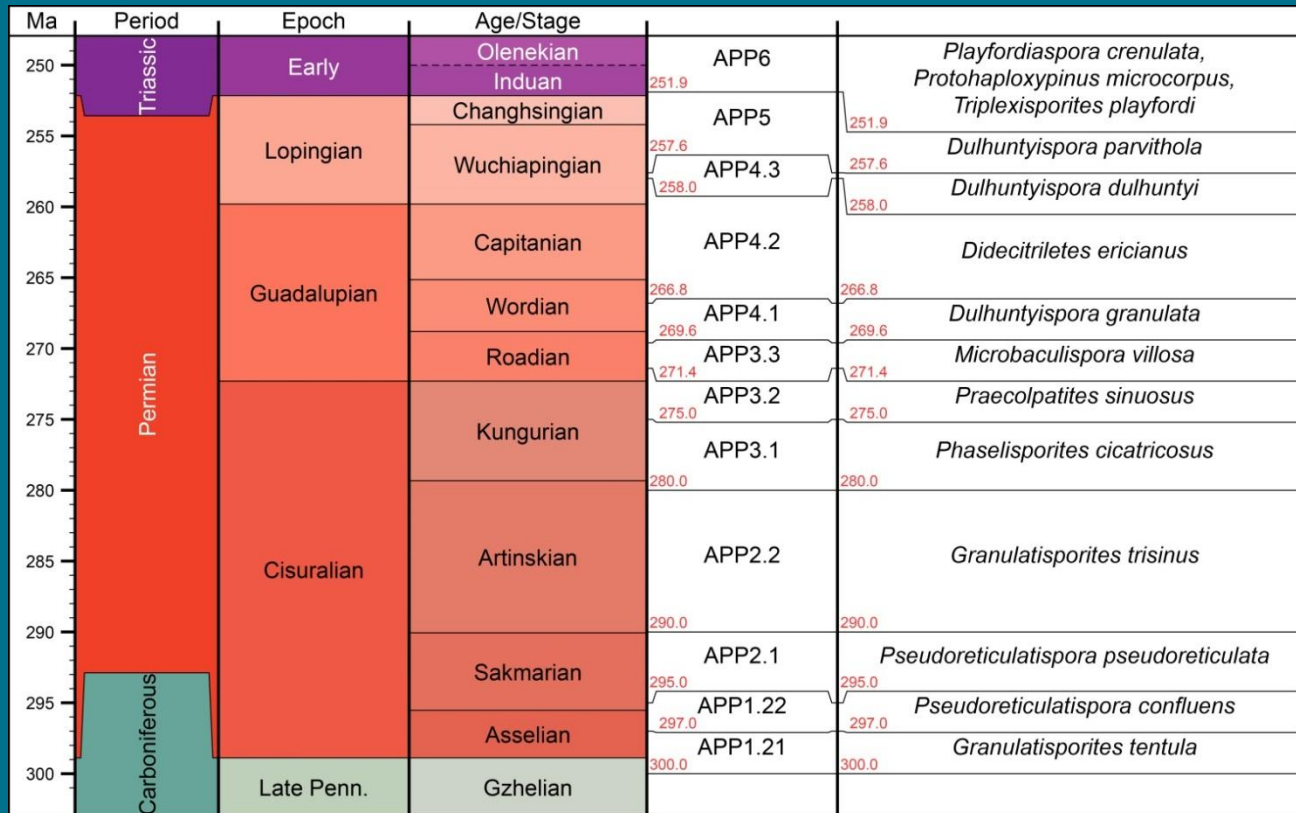
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Revised palynostratigraphy for the Guadalupian and Lopingian

Arrows indicate CA-IDTIMS
dated samples with palynological
control



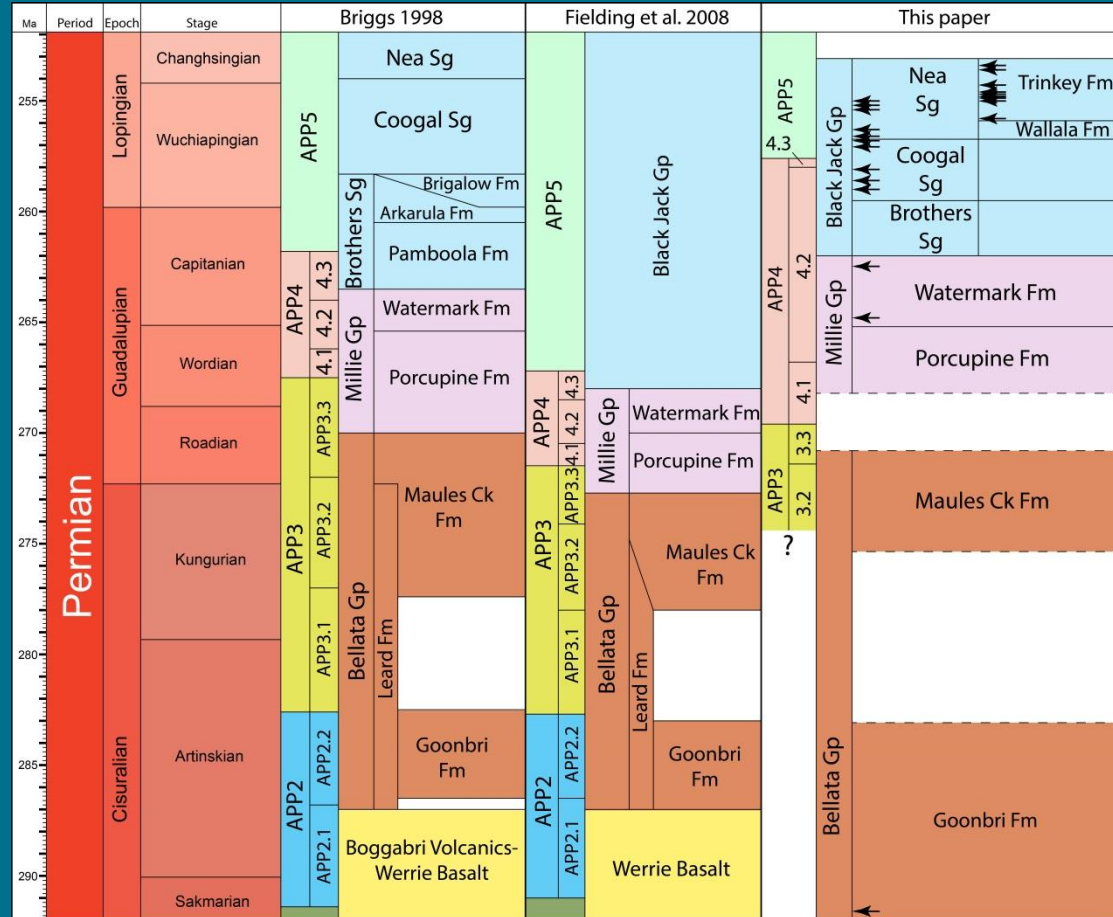
Revised Permian palynostratigraphy



Tadros 1997 correlation

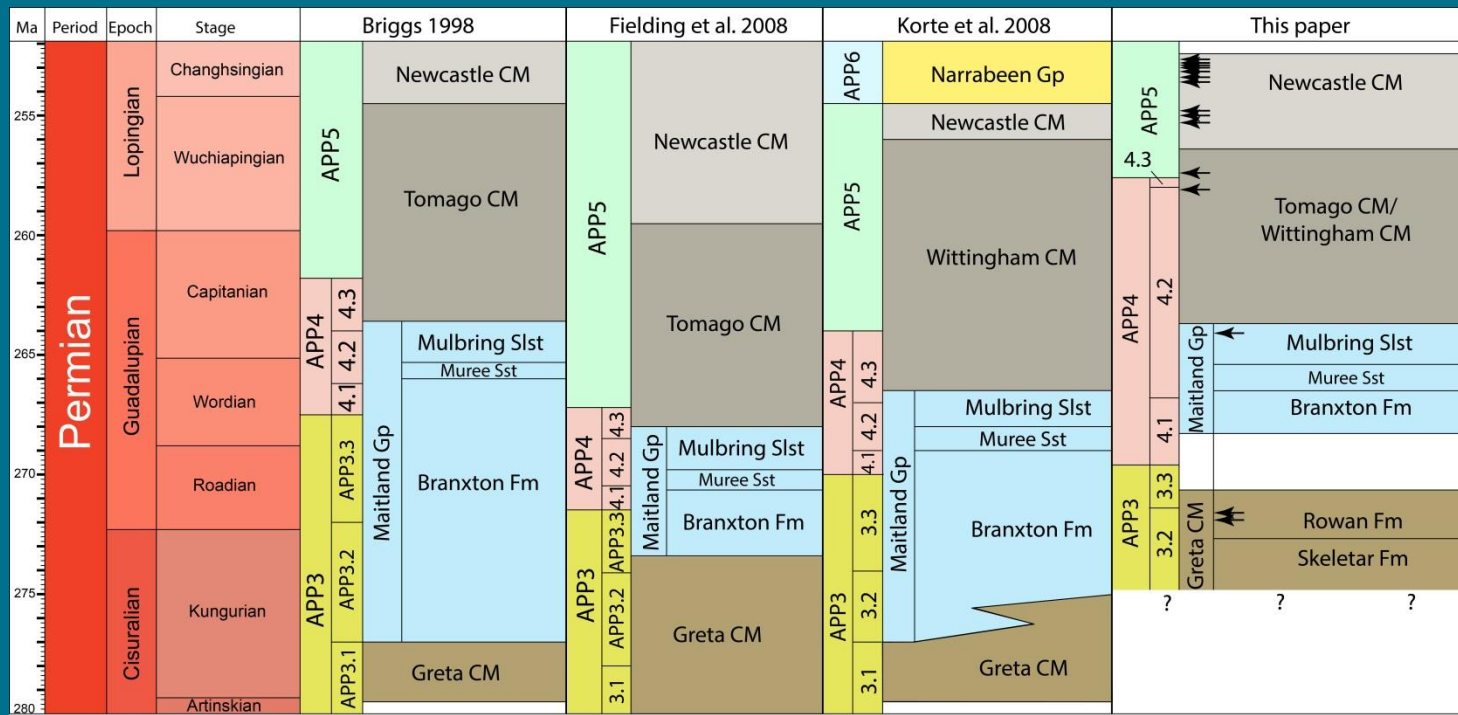
Gunnedah Basin				Hunter Coalfield		Newcastle Coalfield		Western Coalfield		Southern Coalfield						
Deriah Formation						Hawkesbury Sandstone				Wianamatta Group						
Napperby Formation										Hawkesbury Sandstone						
Digby Formation				Narrabeen Group		Narrabeen Group		Narrabeen Group		Narrabeen Group						
Black Jack Group	Nea Sg	Trinkey Formation		Singleton Supergroup	Wollombi C.M.		Newcastle C.M.		Illawarra Coal Measures	Wallerawang Subgroup			Sydney			
		Wallala Formation			Watts Sandstone		Waratah Sandstone			Bargo Claystone						
	Coogal Sg	Benelabri Fm			Denman Fm		Dempsey Formation					Baal Bone Fm		Subgroup		
		Clare Sandstone			Jerrys Plains Sg		Tomago			Charbon Subgroup						
	Brothers Sg	Hoskissons Coal			Archerfield Ss		Coal			Cullen Bullen Subgroup		Erins Vale Formation				
		Brigalow Fm			Bulga Fm					Marrangaroo Cgl						
		Arkarula Fm			Vane Subgroup					Nile Subgroup						
	Pamboola Formation											Cumberland Subgroup				
Millie Group	Watermark Formation			Maitland Gp	Mulbring Siltstone		Maitland Gp	Mulbring Siltstone		Shoalhaven Group	Budgong Sandstone		Budgong Sandstone		Gerrigong Volcanics	
	Porcupine Formation				Muree Sandstone			Muree Sandstone			Berry Siltstone		Berry Siltstone			
					Branxton Formation			Branxton Formation					Nowra Sandstone			
Bellata Gp	Maules Creek Formation			Greta C.M.	Rowan Formation		Greta Coal Measures				Wandrawandian Siltstone		Snapper Point Formation			
	Leard & Goonbri Formations				Skeletal Formation						Snapper Point Formation					
	Boggabri Volcanics & Werrie Basalt			Gyarran Volcanics	Farley Formation		Dalwood Group	Farley Formation			Yarrunga C.M.		Pebbly			
					Rutherford Formation			Rutherford Formation			Yadboro & Tallong Cgls		Beach Formation			
					Allandale Formation			Allandale Formation								
					Lochinvar Formation			Lochinvar Formation								
Seaham Formation					Seaham Formation						Clyde C.M.		Pigeon House Ck Silt		Wasp Head Fm	
															Talaterang Group	

Gunnedah Basin

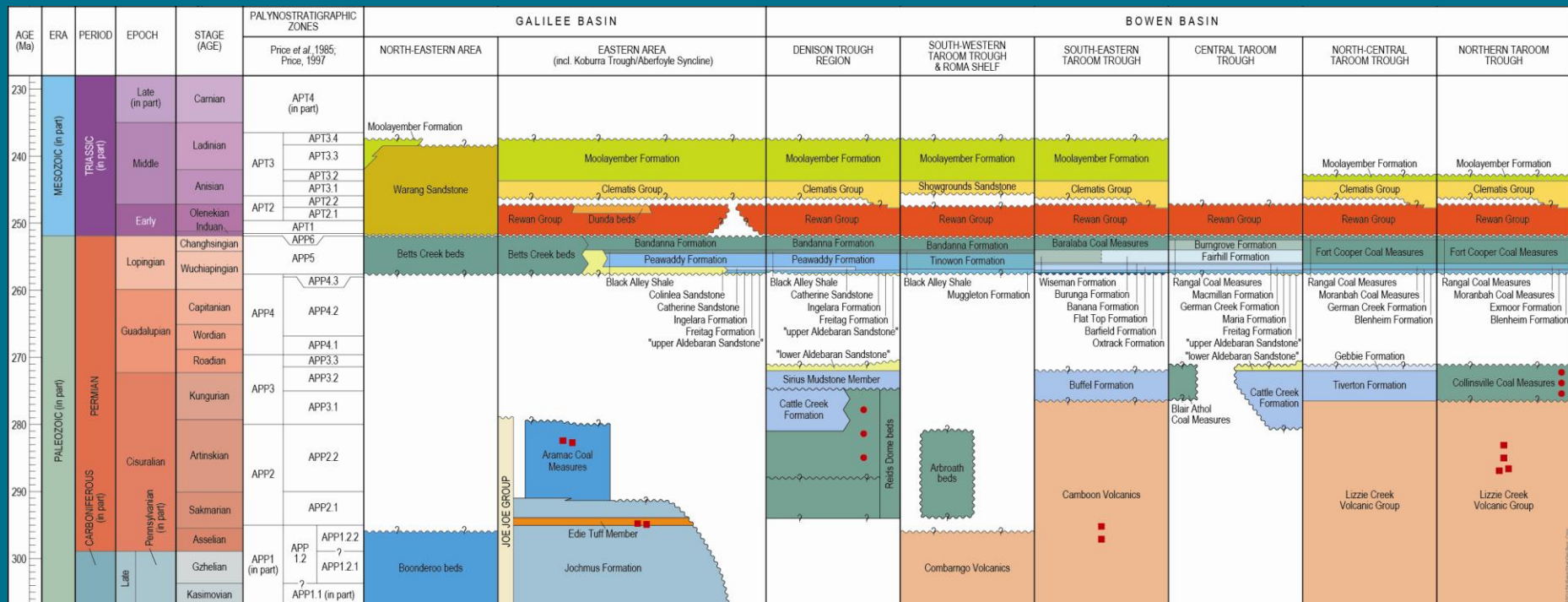


Northern Sydney Basin

Hunter and Newcastle coalfields



Galilee–Bowen transect



Summary

Whole new appreciation of stratigraphic sequence

Real control on depositional rates

Confirmation on lateral correlation within and between basins

Time control on event stratigraphy



Australian Government

Geoscience Australia



Thank you

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