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Pangea: Geochronological correlation of successive environmental and strati-tectonic phases in Europe and Australia

J.J. Veevers *

GEMOC ARC National Key Centre, Department of Earth and Planetary Sciences, Macquarie University, Sydney, NSW 2109, Australia

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ABSTRACT

A robust geochronology based on U–Pb zircon ages in Australia (n = 158) and Europe (n = 376) provides a rigorous test of (1) the model of a climatic–tectonic cycle of a single continent (Pangea) and ocean (Panthalassa) with an icehouse climate alternating with many continents and oceans with a greenhouse climate, and (2) the idea of coeval (320 to 300 Ma) right-lateral shear events in Eastern Australia and Europe followed by earliest Permian (~300 Ma) extension. During Pangean assembly, stress from the oblique collision of Laurussia and Gondwanaland bent the oroclines in Iberia, drove the intense shortening in Central Australia and terminal megakinking in the Lachlan orogen, and possibly drove the bending of oroclines in Eastern Australia. Extension I (~300 Ma, Carboniferous/Permian) followed the first outburst of self-induced (monsoonal) heat from the newly assembled Pangea, and generated fresh accommodation space for globally synchronous sedimentary successions, including the glacial base and succeeding coals of the Gondwana facies. Extension was relieved by sags on (isotropic) cratons and rifts on (anisotropic) fold belts with voluminous volcanics. In Europe, the Variscan orogen was cut into right-lateral magmatic rifts and the craton sagged to accumulate magmatic basins; likewise, the convergent margin of Eastern Australia was cut into a long magmatic rift and the cratonic foreland covered by the Gondwana facies. The end-Permian (251 Ma) sea-level drawdown, climate warming, and severe biotic extinction, with no obvious tectonic cause, were responsible for the Early-Middle Triassic coal gap. A second outburst of heat drove Extension II (235 Ma, Carnian, Late Triassic), expressed as rifts and sags that accumulated a second set of coal-bearing strata. At this time of its largest extent, Pangea underwent incipient breakup by rifting of the Atlantic Margins of North America, Morocco, and Western Europe that developed into 190 Ma drifting.

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* Tel.: +61 2 9858 1034.
E-mail address: john.veevers@mq.edu.au.

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1. Introduction

The ensemble of continent-backed lithosphere in Pangea and ocean-backed lithosphere in Panthalassa (Fig. 1) lasted through the Carboniferous, Permian, and Triassic (340 to 190 Ma) in a unique tectonic–climatic environment. As outlined by Scholle et al. (1995),

> "The Permian was a remarkable time period. It represents the maximum stage of Pangean continental assembly, includes a major global climatic shift from glacial to nonglacial conditions (icehouse–greenhouse transition), and is terminated by one of the most profound faunal/floral extinction events in the Earth's history. In addition, Permian oceans although poorly understood, must have had some quite unique characteristics. Permian seas reached the most extreme values of carbon, sulfur, and strontium isotopic ratios ever achieved in Phanerozoic time, and isotopic values of all three elements abruptly returned to more 'normal' values at, or very close to, the Permo-Triassic boundary."

A robust geochronology based on U–Pb zircon ages in Australia (n = 158) and Europe (n = 376) provides a rigorous test of the model of a climatic–tectonic cycle of a single continent (Pangea) and ocean (Panthalassa) with an icehouse climate alternating with many continents and oceans with a greenhouse climate (Veevers, 1990).