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Abstract

Zircon-bearing rhyolitic and dacitic airfall tuffs in the Late Permian Sydney Basin coal measures provide ideal chronostratigraphic markers due to their widespread occurrence and rapid emplacement. SHRIMP U-Pb zircon dates for several stratigraphically-controlled airfall tuffs are consistent with their relative ages and biostratigraphic data, and indicate that the Illawarra Coal Measures accumulated in less than ~ 12 million years. Isotopic ages of the A waba Tuff and the Burragorang Claystone Member are indistinguishable within analytical uncertainty and support the correlation of these units proposed previously on the basis of geochemical fingerprinti~g. Deposition of coal-bearing sequences in the southern Sydney Basin apparently commenced a few million years before deposition of similar sequences in the Bowen Basin but deposition ceased at the same time in both regions.

Keywords

airfall, dating, shrimp, pb, tuffs, u, geochronology, basing, sydney, measures, coal, GeoQuest

Disciplines

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GEOCHRONOLOGY OF COAL MEASURES IN THE SYDNEY BASIN FROM U-Pb SHRIMP DATING OF AIRFALL TUFFS

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ABSTRACT

Zircon-bearing rhyolitic and dacitic airfall tuffs in the Late Permian Sydney Basin coal measures provide ideal chronostratigraphic markers due to their widespread occurrence and rapid emplacement. SHRIMP U-Pb zircon dates for several stratigraphically-controlled airfall tuffs are consistent with their relative ages and biostratigraphic data, and indicate that the Illawarra Coal Measures accumulated in less than ~12 million years. Isotopic ages of the Awaba Tuff and the Burragorang Claystone Member are indistinguishable within analytical uncertainty and support the correlation of these units proposed previously on the basis of geochemical fingerprinting. Deposition of coal-bearing sequences in the southern Sydney Basin apparently commenced a few million years before deposition of similar sequences in the Bowen Basin but deposition ceased at the same time in both regions.

INTRODUCTION

Deposition of the Sydney Basin coal-bearing sequence was coeval with volcanism associated with subduction along the east coast of Gondwana. Much of the volcanism was explosive and resulted in the formation of many, widely distributed felsic airfall tuffs that generally thin towards the western margin of the basin. Based on their distribution and the contemporaneity with Gondwanan magmatism, the source of the tuffs is attributed to an offshore volcanic belt that has been termed the Currarong Orogen (Jones *et al.*, 1984; Veevers *et al.*, 1994) or the Offshore Uplift (Herbert, 1994; Kramer *et al.*, 2001).

The combination of a low energy environment and rapid burial of deposits in Sydney Basin coal measures was conducive to the preservation of these airfall tuffs, which can be used as chronostratigraphic markers due to their widespread distribution and essentially instantaneous emplacement. Geochemical fingerprinting has been used to correlate Late Permian tuffs and associated tonsteins in the geographically adjacent Newcastle and Wollombi Coal Measures of the northern Sydney Basin (Kramer *et al.* 2001), and three major tuffs in the Illawarra Coal Measures of the southern Sydney Basin (Grevenitz *et al.*, 2003). In addition, the latter study suggested that the Awaba and Warners Bay Tuffs of the northern Sydney Basin correlate with the Burragorang and Farmborough Claystone Members of the southern Sydney Basin, respectively. These studies within and between coalfields have provided a relative time scale for the Permian sequence in the Sydney Basin.

The major aim of the current study was to determine a numerical time scale for the coal measure deposition. We have identified and sampled five, zircon-bearing, rhyolitic to dacitic airfall tuffs that span the stratigraphic interval from the top of the Shoalhaven Group to just below the Hawkesbury Sandstone in the southern Sydney Basin (Figure 1). In addition, a sample of the Awaba Tuff from the northern Sydney Basin was also collected to determine its age and correlation with the Burragorang Claystone Member.

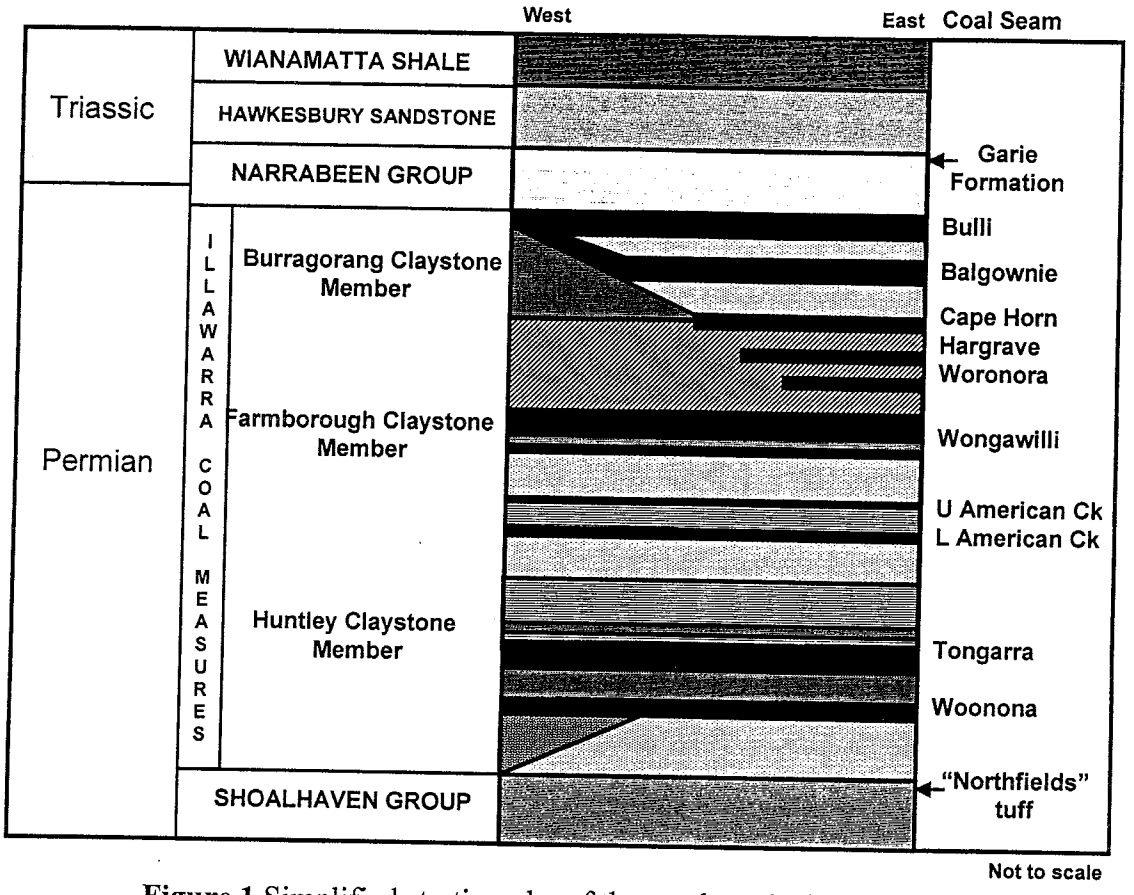

Figure 1 Simplified stratigraphy of the southern Sydney Basin.

RESULTS

Zircon grains were separated using standard crushing and heavy-liquid procedures. All sampled tuffs contain clear, euhedral, mainly prismatic zircon crystals with pyramidal terminations. Cathodoluminescence images reveal zoned internal structures indicative of a relatively simple, melt-precipitated history for the grains. SHRIMP II at the Research School of Earth Sciences, Australian National University, was used to determine the U-Pb age of crystallisation of these zircon grains. Because the airfalls are relatively cool, distal pyroclastic units, zircon crystallisation probably would have preceded stratigraphic emplacement but the time difference between crystallisation and eruption would be within the analytical uncertainty on measured isotopic ages.

U-Pb SHRIMP dates have been determined for the Northfields tuff (informal unit a few metres below the top of the Shoalhaven Group), Huntley Claystone Member, Farmborough Claystone Member (two subunits 1 m apart), Burragorang Claystone Member and the Garie Formation. Within analytical uncertainty the dates for the five units concur with their relative ages based on stratigraphic positions. In addition, the isotopic data support the Late Permian and Triassic ages of the units based on biostratigraphic and other evidence, and indicate that the Illawarra Coal Measures were deposited in the relatively short time interval of less than ~12 million years. This estimate is very similar to that proposed by Gulson *et al.* (1990) who suggested that the combined Tomago and Newcastle Coal Measures of the northern Sydney Basin accumulated in ~10 million years.

The Awaba Tuff occurs near the top of the Newcastle Coal Measures and can be correlated geochemically with the Burragorang Claystone Member from near the top of the Illawarra Coal Measures (Grevenitz *et al.*, 2003). This proposed correlation is supported by our SHRIMP dates for these two units and a conventional U-Pb date on zircon from the Awaba Tuff published by Gulson *et al.* (1990). All three dates are indistinguishable within analytical uncertainty.

The new U-Pb dates provide a basis for comparing the timing of development of coal measures in the Sydney and Bowen Basins. The Platypus Tuff Bed of the Moranbah Coal Measures (basal unit of the Blackwater Group, Bowen Basin) has a SHRIMP U-Pb zircon age of 258.9±2.7 Ma (Michaelsen *et al.*, 2001). This date implies that deposition of coal-bearing sequences in the Bowen Basin commenced a few million years after deposition of similar sequences in the southern Sydney Basin but deposition ceased at the same time (at the Permian-Triassic boundary; 251 Ma) in both regions.

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