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Origin and time-space distribution of hydrothermal systems in east-central Australian sedimentary basins: Constraints from illite geochronology and isotope geochemistry.

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Some well-known precious mineral deposits and hydrocarbon resources occur extensively in east-central Australian sedimentary Basins. The metal occurrences are abundant in northwestern and eastern part of Queensland, whereas no significant deposits are known in large areas further south, which may, however, be hidden beneath the Jurassic-Cretaceous sedimentary basins. Important hydrocarbon resources exist within the Jurassic-Cretaceous sedimentary rocks at relatively shallow depths, of which the distribution represent zones of high paleo-geothermal gradients. This study examines the time-space distribution in relation to the regional tectonic history of concealed metal deposits and areas of high paleo-geothermal gradient leading to hydrocarbon maturation. To this end, authigenic illitic clay minerals representing various locations and stratigraphic depths in east-central Australia were investigated, of which the Rb–Sr and Ar–Ar geochronology and stable isotope geochemistry assist in delineating zones of hydrothermal systems responsible for hydro-carbon maturation/migration and potentially ore deposition.

The Late Carboniferous – Early Permian crustal extension that affected large areas of eastern Australia and led to the epithermal mineralisations (e.g., the Drummond Basin) is also recorded in northern South Australia and southwest Queensland. A Late Triassic – Early Jurassic tectonic event being responsible for coal maturation and gas generation in the Bowen Basin and the epithermal mineralisation in the North Arm goldfield in SE Queensland likewise affected the areas much further west in Queensland. Some illites from the basement in outback Queensland and fault gouges from the Demon Fault in NE New South Wales yield younger Rb–Sr and Ar–Ar ages indicating the effect of hydrothermal processes as a result of a Middle-Upper Jurassic tectonic event. The majority of illite samples from the crystalline basement rocks, Permian Cooper Basin, and Jurassic-Cretaceous Eromanga Basin from all over east-central Australia give Cretaceous ages (∼130 to ∼60 Ma) reflecting episodic hydrothermal events restricted to certain tectonic zones. The Cretaceous events were responsible for the hydro-carbon generation/maturation in the Cooper, Eromanga, and Gunnedah Basins and deposition of some Au and basemetal resources in the eastern part of Queensland. The stable isotope composition of the Late Triassic – Early Jurassic illites in eastern Queensland and all mid-late Cretaceous illites from outback and eastern Australia is distinctively different with low [U+F064]18O and [U+F064]D values indicating meteoric-hydrothermal systems due to extensional tectonics. Results of this study suggest that illite geochronology and geochemistry is a powerful tool in delineation of concealed hydrothermal systems that were responsible for ore generation and hydrocarbon/maturation and migration.