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No evidence for thermogenic methane release in coal from the Karoo-Ferrar large igneous province

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The Early Jurassic Toarcian oceanic anoxic event (T-OAE) and concurrent negative carbon-isotope (δ^{13}C) excursion have been attributed to either the release of methane (CH_4) clathrates or thermogenic CH_4 gas associated with the Karoo-Ferrar large igneous province into coals and organic-rich shales. ^{12}C-enriched thermogenic CH_4 production associated with the Karoo-Ferrar would result in residual material being ^{12}C-depleted nearer the intrusions. In this study, geochemical analyses (carbon isotopes, volatile matter (VM), vitrinite reflectance (R_o)) are reported for two coal transects associated with dykes intruding the No. 4L coal in the Highveld Coalfield, Karoo Basin, South Africa. VM decreases from over 35% to around 15% in one transect, and the second transect shows a less pronounced decrease (from >25% to ~16%). Accompanying the decrease in VM content is an increase in R_o from background levels of around 0.7% to over 4% adjacent to the dyke; used as a palaeo-geothermometer, R_o values indicate background temperatures of 100°C increasing to >300°C close to the contact. Despite changes in VM and R_o, there are no significant changes in δ^{13}C, certainly not of the magnitude that would be expected associated with large-scale thermogenic CH_4 generation. These and other Gondwanan coals have low vitrinite and liptinite contents (components more prone to CH_4 generation), in part explaining the modest decreases in VM adjacent to the dykes. This, combined with the relatively narrow metamorphic aureole surrounding the intrusions and the likelihood that at least some of the volatiles generated by the intrusion were trapped as coalbed CH_4 or condensed as pyrolytic carbon, suggests only limited CH_4 release. In addition, based on original estimates of moisture contents in these coals and the depth at time of intrusion (1,000–2,000 m) the dykes would have lost most of their energy heating and evaporating water, thus having very little remaining energy to generate thermogenic CH_4.