Geochemical Investigations in Earth and Space Science: A Tribute to Isaac R. Kaplan

Editors: R.J. Hill, J. Leventhal, Z. Aizenshtat, M.J. Baedecker, G. Claypool,
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Factors controlling the carbon isotopic composition of methane and carbon dioxide in New Zealand geothermal and natural gases

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Abstract—Gases from Taupo Volcanic Zone (TVZ) and Taranaki natural gas fields of New Zealand show both similarities and differences. The mantle helium signal is strong in both fields. In Taranaki, CH_4 generally predominates while in TVZ, CO_2 predominates and CO_2, CH_4, H_2 and N_2 concentrations relative to mantle-derived ^3He are correlated with B/Cl ratios. In the high B/Cl areas of TVZ $\delta^{13}C(CH_4)$ values are mainly in the −25 to −28‰ range, possibly from high temperature decomposition of kerogen, whereas in the lower B/Cl areas other processes result in $\delta^{13}C(CH_4)$ values of −14 to −37‰.

The relatively high heat flow in parts of the Taranaki Basin appears to have accelerated the natural gas generation process in which $\delta^{13}C(CH_4)$ is initially much more negative than the source organics (−27 to −29‰) but becomes more positive with increasing maturity of the source rocks. This results in a range of $\delta^{13}C(CH_4)$ values from −32 to −48‰.

Isotopic equilibrium between $^{13}CO_2$ and $^{13}CH_4$ does not appear likely in Taranaki. In TVZ apparent isotopic temperatures are higher than reservoir temperatures but show fair correlation. This may relate both to a hydrocarbon maturity effect and to a source effect but this does not fully explain the $\delta^{13}C(CH_4)$ and $\delta^{13}C(CO_2)$ distribution within some fields.