O16

# ROLE OF PRESSURE ON EXTENT OF PETROLEUM GENERATION

Ronald HILL and Michael LEWAN

*United States Geological Survey, Box 25046, MS 977, Denver Federal Center, Denver, CO 80225*

Hydrous pyrolysis experiments were conducted on a thermally immature Devonian New Albany Shale source rock at 300, 326, and 356 ºC for 72 hours under pressures from 0.1 to 2.1 kbar to evaluate the role of pressure on petroleum generation. Previous studies have shown that these conditions depict the full range of the two-step process for petroleum generation with kerogen to bitumen taking place at and below 330°C for 72-h durations and bitumen to oil taking place at and above 330°C for 72-h durations (Lewan, 1985). The experiments have been grouped into four pressure regimes as shown in Figure 1. The lowest-pressure regime (0.1-0.2 kbar) represents conventional hydrous pyrolysis experiments where pressures are predominantly controlled by the vapor pressure of water along its vapor-liquid curve. The highest-pressure regime (1.8-2.1 kbar) represents lithostatic pressures at subsurface depths of 7.4 to 8.6 km.

With the start of thermal maturation, the kerogen partially decomposes into soluble, viscous, resin- and asphaltene-rich bitumen. Decreasing kerogen content with corresponding increase in bitumen yield evinces this first overall reaction. As thermal maturation proceeds, the second of the two-step process commences with the decomposition of bitumen to free-flowing liquid hydrocarbon-rich oil that is compositionally similar to natural crude oils (Ishiwatari et al, 1976). Decreasing bitumen and constant kerogen content with increased oil yields evinces this second overall reaction.

Figure 1 shows the results of hydrous pyrolysis at the 4 different pressure regimes. The kerogen to bitumen reaction is prevalent at temperatures less than 330ºC for 72h, whereas the bitumen to oil reaction is best represented at 330 and 356ºC for 72h. These results indicate that while there might be some pressure effects on kerogen decomposition to bitumen, the most pronounced effects are on the decomposition of bitumen to oil. This decrease in oil generation as pressure increases might be a result of cross-linking reactions becoming more dominant than cracking reactions during the thermal decomposition of bitumen to oil. In addition to pressure-induced cross-linking in bitumen reducing oil yields, pressure might also decrease the rates of bitumen to oil cracking reactions through activation volume controls on reaction rates. An implication of the latter effect is that time-temperature-pressure conditions in some parts of a sedimentary basin could result in oil generation taking place at deeper depths and longer times that typically predicted in kinetic models.

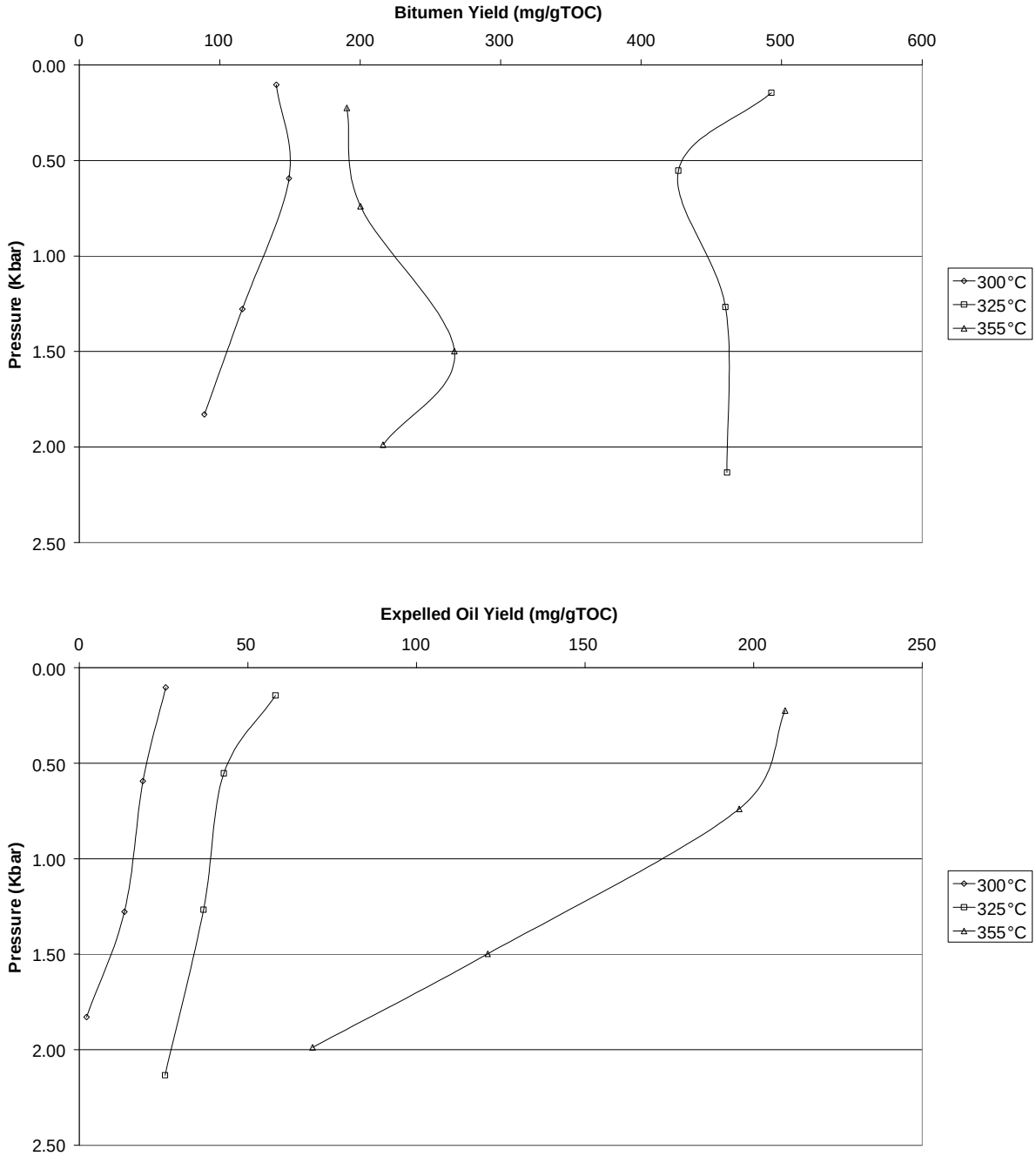


Figure 1. Changes in bitumen and expelled oil yield as a function of temperature and pressure.

## REFERENCES

Lewan, M., 1985. Evaluation of petroleum generation by hydrous pyrolysis experimentation. Philosophical Transactions of the Royal Society 315, 123-134.

Ishiwatari, R., Ishiwatari, M, Kaplan, I. R., and Rohrback, B., 1976. Thermal Alteration of young kerogen in relation to petroleum genesis. Nature 264, 347-349.