O58

THE LIFECYCLE OF DIAMONDOID CAGE HYDROCARBONS IN NATURE

Zhibin WEI[1], J. Michael MOLDOWAN[1], Jeremy DAHL[1], Dan JARVIE[2] and Ron HILL[3]

1. Department of Geological and Environmental Sciences, Stanford University, CA 94305-2115, USA
2. Humble Geochemical Services, Division of Humble Instruments & Services, Inc., P. O. Box 789, Humble, Texas 77347, USA
3. U.S. Geological Survey, Box 25046, Denver Federal Center, MS 939, Denver, CO 80225, USA

Diamondoids, also called “nanodiamonds”, can be regarded as extraordinary small fragments of a diamond lattice. They naturally occur in virtually all petroleum and are composed of fused cyclohexane rings all in chair conformation forming a cage structure. These nanodiamonds have shown potential in many research fields, e.g., nanotechnology, pharmacology, petroleum geochemistry. Although lower diamondoids (adamantanes, diamantanes and triamantanes) have been formed in laboratory experiments by super-acid rearrangement of a wide variety of isomeric precursor molecules, the origin of diamondoids in nature has puzzled organic geochemists for several decades.

In this study, we attempt to ascertain the organic precursors, formation mechanisms, and fate of diamondoids, which may shed light on the lifecycle of diamondoids in nature. The present work has clearly demonstrated that diamondoids in nature originate from petroleum or petroleum precursor molecules through molecular rearrangements involving numerous carbonium ion intermediates in the presence of acidic clays. The pattern of diamondoid formation follows carbonium ion mechanisms rather than free radical mechanisms, as supported by the findings that acidic clays largely facilitate the generation of diamondoids from kerogen compared with S^0 and other minerals (Wei et al., 2006a). Diamondoid analysis was performed on a large set of oil and condensate samples. Our results indicate that diamondoids become enriched in oil as oil cracking increases (Dahl et al., 1999). Despite their high stability, diamondoids are perishable in nature. Compelling evidence can be provided by thermal destruction of diamantane at high temperatures in the laboratory, by a dramatic drop in the abundance of diamondoids in the extracts of highly mature coals and sedimentary rocks (Wei et al., 2006b), and by the biodegradability of adamantane in petroleum reservoirs where microbial activities are evident. Therefore, diamondoid cage compounds have their lifecycle in nature: birth, enrichment and demise (Figure 1).

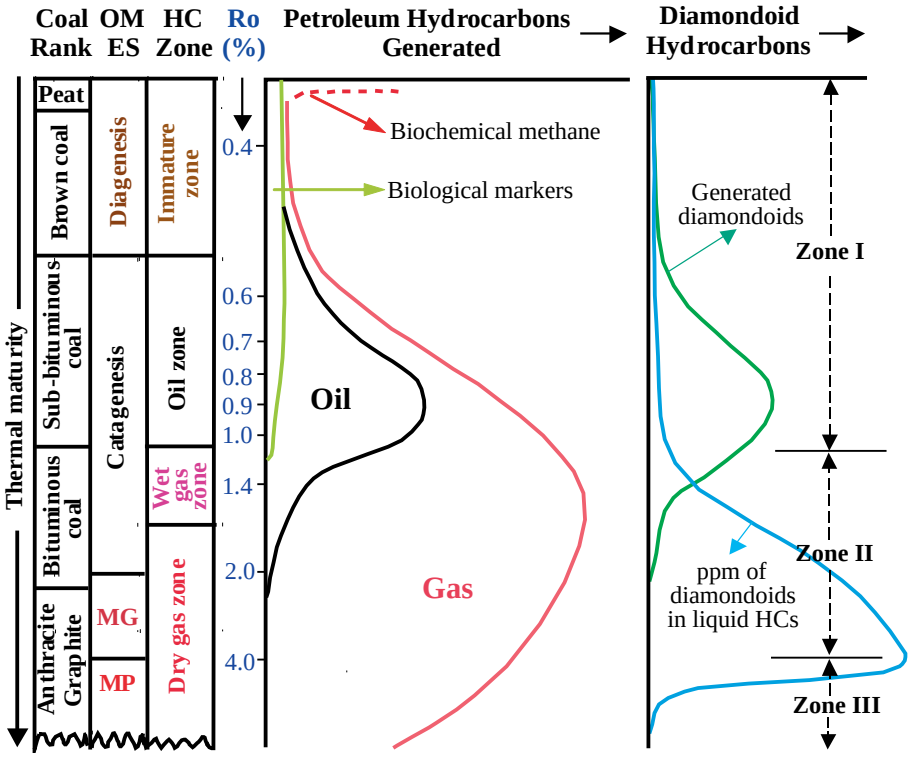

Figure 1. General schemes for formation of petroleum hydrocarbons and diamondoids, concentrations of diamondoids in liquid hydrocarbons, and stages of coal rank as a function of thermal maturity of the source rock, showing the "lifecycle" of diamondoids in nature. Coal Rank = stages of coal rank; OM ES = main stages of evolution of organic matter; HC Zone = main zones of hydrocarbon generation; MG = metagenesis; MP = metamorphism; Zone I = diamondoid birth/generation; Zone II = diamondoid generation and enrichment; Zone III = diamondoid destruction.

REFERENCES

Dahl, J.E., Moldowan, J.M., Peters, K., Claypool, G., Rooney, M., Michael, G., Mello, M. and Kohnen, M. (1999) Diamondoid hydrocarbons as indicators of oil cracking. *Nature* **399**, 54-66.

Wei, Z., Moldowan, J.M., Goldstein, T. and Jarvie, D. (2006a) The catalytic effects of minerals on the formation of diamondoids from kerogen macromolecules. *Organic Geochemistry* **37**, 1421-1436.

Wei, Z., Moldowan, J.M., Jarvie, D. and Hill, R. (2006b) The fate of diamondoids in coals and sedimentary rocks. *Geology* **34**, 1013-1016.