ANALOGUES BETWEEN WATER IN GRANITE MELTS AND PETROLEUM FORMATION

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Water is ubiquitous within the Earth's crust and has long been recognized as a critical component in deep crustal areas undergoing metamorphism. Similarly, water in granite melts has been shown to be critical to granite melting points, mineral phase relations, element partitioning between melt and mineral phases, and transport properties. Although the specific role of water remains an issue in petroleum formation, experimental studies on petroleum source rocks pyrolysed with and without water clearly indicate that water is an important component. Petroleum formation involves two overall reactions. The first of these reactions is the thermal decomposition of kerogen, which is the insoluble and dominant organic solid phase in thermally immature source rocks. With initial heating, kerogen partially breaks down to a soluble polar-rich high-molecular-weight tarry phase referred to as bitumen. A net volume increase associated with this reaction results in the bitumen expanding into the micro-porosity to form a continuous bitumen phase impregnating the groundmass of the source rock. Experiments have shown that water is not important in this step, but water in the original micro-pores and in surrounding fractures provides a source for dissolved water in the bitumen. Similar to water dissolved in granite melts, the solubility of water in bitumen plays a significant role. It is this dissolved water in the bitumen phase and not the surrounding bulk water in fractures or voids that becomes critical in the second overall reaction, which is the thermal decomposition of the polar-rich bitumen phase to a hydrocarbon-rich oil phase. During this overall reaction, the dissolved water provides a source of hydrogen that promotes thermal cracking and facilitates immiscibility between the bitumen and oil phases. These conditions result in a net volume increase and the expulsion of the oil from the water-laden bitumen in the source rock. The ability of water in pyrolysis experiments to simulate organic phases like those observed in nature helps petroleum-formation studies move away from sole emphasis on organic components (i.e., saturates/aromatic/resin/asphaltene) and, like granite-melt studies, allows examination of the collective behavior of both components and phases.