The coupled generation of organic acids and hydrocarbons during source rock maturation

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Introduction: Organic acids which are commonly detected in oilfield waters, can partially enhance reservoir properties. Previous studies have suggested that cleavage of the oxygen-containing functional group in kerogen is a major source of organic acids. However, this cleavage is assumed to occur before the source rock enters the oil window. If this is correct, then these acids can dissolve only minerals in the source rocks. Presently, no detailed study of the generation of organic acids during the whole thermal maturation of source rocks has been conducted. It is unclear whether organic acids could migrate into reservoirs.

Aim: This research simulated the thermal evolution of source rocks in order to build a coupled model of organic acid and hydrocarbon generation, and investigate if organic acids generated in source rocks can migrate into reservoirs.

Methods: Three immature source rocks containing type I, II, and III kerogens were crushed to 200 mesh. These powders, along with deionized water, were sealed in Au tubes and heated to 220–360°C for 72 h (EasyRo 0.37–1.16%). All the run products, including organic acids, gas, and bitumen, were analyzed.

Results: At all temperatures, the organic acids dissolved in the waters are composed of formate, acetate, propionate, and oxalate. Acetate is the major compound with a modal proportion of >83%. The maximum yield of total organic acids was from source rocks containing type I kerogen (31.0 mg/g TOC), which was twice that from source rocks containing type II and III kerogens (13.3–15.4 mg/g TOC). However, for the type I and II kerogen-bearing source rocks, the organic acids reached a maximum yield (EasyRo = 1.16%) following the bitumen generation peak (EasyRo = 0.95%). Organic acids from type III kerogen-bearing source rocks reached their maximum yield (EasyRo = 0.95%) before the source rock entered the gas window (EasyRo > 1.16%).

Conclusions: Our data suggest that the generation of organic acids is coupled with the generation of oil from type I and II kerogen-bearing source rocks, but form earlier than gas from type III kerogen-bearing source rocks. As such, some organic acids dissolved in pore waters are possibly expelled from source rocks containing type I and II kerogen with oils, which can then migrate into reservoirs. Migration of organic acids into reservoirs from source rocks containing type III kerogen
is also possible in some situations. For example, when a source rock is rapidly buried for a short period, such as in the Kuqa Depression, Tarim Basin, China, the generation interval of organic acids and gas is short. Both could be expelled outside and migrate upwards into reservoirs. In conclusion, organic acids derived from source rocks can contribute to reservoir alteration.