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Microbiological Dynamics in Rock and Fluid Characterization, An Overview

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The surface crust and waters are major sites for the activities of microorganisms that essentially form the greatest part of the biomass on planet Earth. From present observations microorganisms can thrive in any environment where there is available water and survive in any other environment where water is not adequately available. In the development of conceptual fluid and rock characterization the roles of microorganisms have been largely ignored. This ignorance has been partly perpetrated by the fact that microbial activities can easily be interpreted as being chemical in origin, the activities are considered to occur below the visible range, and reductionist microbiologists have insisted on using the antiquated Linean systems for study and identification. The other approach involves the acceptance that microorganism function in community structures which will adapt and change as the micro-environments changes.

The premise developed for determination of these microbial communities involves a three staged approach called the “A-B-C” approach. Here the “A” refers to activity monitored as adenosine triphosphate (ATP), “B” refers to the biology, and “C” the community characterization. In the practice of the art the first investigation is of the ATP by a method called the enhanced total ATP method (E-tATP) which commonly gives data in the 10-12g range as picograms/mL or gram. Biology is commonly restricted to the bacterial communities recognized by their reaction patterns on biological activity reaction tests (BART™) which generates community identification and population data. Characterization of the community is performed using the rapid agitation static incubation (RASI) followed by the microbiological identification determination (MIDI™) using the fatty acid methyl esters (FAME) located primarily in the cells walls of the members of that community. This results in the development of a specific FAME “fingerprint” that can be compared in the generated FAME library. Rock and fluids each have unique microbiological community loads and it should be recognized that there is in the practice of microbial ecology no such as thing as a sterile environment if there is a presence of liquid water. Samples may appear sterile simply because the test methods do not allow either enough time or the appropriate conditions that would allow the community to become recognizable by activities or growth. Past practices of using agar-based cultural techniques has seriously precluded a comprehensive understanding of the significance of microorganisms within rocks and fluids.

Microbiologically influenced activities are more defined in fluids than in the rocks where the role may be limited to the bio-concretious formation of the sedimentary rocks and clays. For the fluids then there are two basic “solvents” to consider which water (as the universal solvent) are and petroleum hydrocarbons (as various forms of crude, tar and asphaltenes). For groundwater there is already a body of understanding of the manners in which microbiological communities do influence the functioning of extraction and injection wells. This influence involves the communities generating a common biomass which would include solid attached growths, floating bio-colloidal particles and a small minority of mobile (freely dispersed “swimmers”) microorganisms in the fluid flow. Commonly it is the “swimmers” that are most easily picked up in any sample and possibly some bio-colloids but no attached biomass unless it is disrupted. Characterizing of groundwater flow with microbiological confidence needs to employ groundwater sampling methods that do disrupt the attached biomass if the full nature of the microbiological challenge associable with plugging, clogging and corrosion is to be recognized. For this

the dispersant of choice in CB-D which is non biocidal and yet as a sterilized 0.5% solution can after agitation or surging cause the attached biomass to collapse and generate samples that have much improved statistical variance. This method was originally developed for the treatment (rehabilitation) of extraction and injection wells as well as for the monitoring of bioremediation sites. In the latter case the surging of the dispersant solution through the monitoring wells being evaluated gave higher populations with improved confidence.

Crude oil is another fluid that lacks detailed microbiological understanding. Generally the microbiology is more related to the produced waters which are a secondary product associable with failing oil and gas wells. Methodologies have been developed based on the A-B-C approach which can investigate the bacteriological loading in crude. This loading is relatable to the water content in the oil with 0.2% or less being considered very acceptable and >5% likely to cause rapid microbiologically influenced corrosion (MIC). For the determination of the bacteriological loadings using the A-B-C the initial step is to take a 4mL of the crude to be evaluated and float that sample on 196mL of sterile 0.5% CB-D solution and agitate for four hours using magnetic stirring. Once agitation has been completed then the microorganisms that were within the crude oil sample would have become dispersed into the sterile CB-D solution creating microbiological activity measurable using the A-B-C technologies. It now becomes possible to determine the intrinsic microflora that are routinely in the oil and affecting many of the characteristics of that oil including the rick of MIC associable events.