

Worldwide Occurrences and Significance of Secondary Microbial Methane Formed During Petroleum Biodegradation

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Secondary microbial methane is a terminal product of anaerobic petroleum biodegradation. It is possible to recognize such gas in subsurface using geological (e.g., association with biodegraded oils in the same or deeper reservoirs) and geochemical (e.g., “dry” hydrocarbon composition with $\delta^{13}\text{C}$ of methane from -40‰ to -55‰ and often positive $\delta^{13}\text{C}$ of CO_2) evidences. Occurrences of secondary microbial methane have been documented in oil, gas and gas hydrate accumulations in the Western Siberia (Russia), San Joaquin and Los Angeles (California), North West Shelf, Gippsland and Otway (Australia), Liaohe and Bohai Bay (China) basins and in the North Slope of Alaska, offshore West Africa, Japan, Alberta (Canada), North Sea, Gulf of Mexico. In addition, secondary microbial methane may be present in petroleum accumulations of Nile delta, Emba area and Buzachi peninsula (Kazakhstan), Cuban, Volga-Ural, Timan-Pechora and Leno-Viluy petroleum areas (Russia), Dneprovo-Donetsk area (Ukraine). Because the subsurface occurrences of secondary microbial gas have only recently started to be recognized, it is difficult at this time to assess how much secondary microbial methane currently occurs in the subsurface. However, it appears that at least eight fields (seven fields in the northern Western Siberia and the Troll field in the North Sea) in the list of 20 largest gas fields with remaining reserves in the world contain some secondary microbial methane. It is possible that secondary microbial methane generated from biodegraded petroleum may be volumetrically more important in the global natural gas endowment than primary microbial methane generated from decomposed organic matter. It has been estimated that there are 3,396 billion bbl of heavy oil in 192 basins and 5,505 billion bbl of natural bitumen in 89 basins (originally in place), most of which originated from petroleum biodegradation in shallow sediments (Meyer et al., 2007). I estimate that up to ~83,000 tcf of secondary microbial methane was generated in currently existing biodegraded petroleum accumulations. This methane was partially accumulated as oil-dissolved, free and hydrate-bound gas in reservoirs, but most of it apparently escaped into the shallow overburden, atmosphere and ocean. Carbon dioxide and methane generated during petroleum biodegradation represent potent greenhouse gases and likely affected both climate change and global carbon cycle in the geological past.