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Migration and storage of methane in the Martian crust

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Several detections of methane in the Martian atmosphere have been reported from Earth-based and Mars orbit instruments with abundances ranging up to tens of ppbv, while in-situ measurements performed by the MSL rover at Gale crater showed some peaks up to 7 ppbv. A variety of methane formation mechanisms occurring in the subsurface have been proposed such as abiotic synthesis through Fischer-Tropsch Type (FTT) reactions. After its generation at depth, Martian methane can migrate upwards and be either directly released at the surface or trapped in subsurface reservoirs, such as clathrate hydrates, where it could accumulate over long time before being episodically liberated during destabilizing events. When ascending through stratigraphic layers, methane can move via one or several transport mechanisms. Seepage can occur through advection, the main CH_4 transport process on Earth, driven by pressure gradients and permeability and generally associated to fracture networks. Another transport mechanism is diffusion, which is mainly controlled by concentration gradient. This process is not efficient on short timescales and short-lived methane plumes related to diffusion should therefore originate from very shallow depths.

In this work, we model the subsurface transport of methane on Mars and its subsequent trapping in clathrate hydrates. For the latter, the effect of the clathrate formation pressure is especially examined, while methane subsurface transport is studied considering adsorption onto, advection and diffusion through the regolith.