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Possible detection of perchlorates by the Sample Analysis at Mars (SAM) Instrument: Comparison with previous missions

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The first chemical analysis of soluble salts in the soil was carried out by the Phoenix Lander in the Martian Arctic [1]. Surprisingly, chlorine was present as magnesium or calcium perchlorate at 0.4 to 0.6 percent. Additional support for the identification of perchlorate came from the evolved gas analysis which detected the release of molecular oxygen at 350-550C [1]. When Mars-like soils from the Atacama Desert were spiked with magnesium perchlorate (1 percent) and heated using the Viking GC-MS protocol, nearly all the organics were combusted but a small amount was chlorinated, forming chloromethane and dichloromethane [2]. These chlorohydrocarbons were detected by the Viking GC-MS experiments when the Martian soil was analyzed but they were considered to be terrestrial contaminants [3]. Reinterpretation of the Viking results suggests <0.1 percent perchlorate and ppm levels of organic carbon at landing site 1 and 2 [2]. The suggestion of perchlorate in the Viking sites [2] has been challenged on the grounds that the detected compounds (CH₃Cl and CH₂Cl₂) were carried from Earth [4]. Recently the Sample Analysis at Mars (SAM) instrument on board the Mars Science Laboratory (MSL) ran four samples from an aeolian bedform named Rocknest. The samples analyzed were portioned from the fifth scoop at this location. The samples were heated to 835C at 35C/min with a He flow. The SAM QMS detected a major oxygen release (300-500C) [5], coupled with the release of chlorinated hydrocarbons (chloromethane, dichloromethane, trichloromethane, and chloromethylpropene) detected both by SAM QMS and GC-MS derived from known Earth organic contaminants in the instrument [6]. Calcium perchlorate appears to be the best candidate for evolved O₂ in the Rocknest samples at this time but other Cl species (e.g., chlorates) are possible and must be evaluated. The potential detection of perchlorates in Rocknest material adds weight to the argument that both Viking Landers measured signatures of perchlorates. Even if the source of the organic carbon detected is still unknown, the chlorine source was likely Martian. Two mechanisms have been hypothesized for the formation of soil perchlorate: (1) Atmospheric oxidation of chlorine; and (2) UV photooxidation of chlorides catalyzed by mineral catalysts [7]. The presence of soil perchlorates in the Martian surface has important implications for the detection of organics [2], carbonates [8] and nitrates [9] by SAM.

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