Soil gases origins: implications for mineral exploration

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The mineral exploration industry is successful in discovering shallow deposits, but the 21st century is faced with a considerable challenge to discover new deposits that sit deeper. The thickness and complexity of cover impacts the reliability of conventional surface exploration techniques. Therefore, in order to minimise the risk, cost and environmental impact of future mineral exploration campaigns, novel exploration tools need to be developed. Gases are highly mobile and can potentially migrate through thick overburden toward the surface, hence, soil gases could become the next exploration technique for mineral deposits. Yet, despite some empirical success, a lot remains to be understood before soil gases can be reliably used as mineral exploration tools. Here, sterile and non-sterile laboratory weathering experiments indicate that sulphur gases are produced by chemical oxidation reactions, and are catalysed by the presence of microbes. Carbon disulphide (CS_2) is the most abundant gas produced from pyrite, chalcopyrite, sphalerite and galena and traces of carbonyl sulphide (COS) were also detected. Sulphur dioxide (SO_2) is also produced in non-sterile experiments. To further understand the role played by microbes in the production of sulphur gases, bioleaching experiments of ore were performed. Sulphur gases were also produced during bioleaching, along with a variety of hydrocarbon gases and aerosols. Hydrocarbon composition varied with different microbial bioleaching communities, ore and temperature. These results indicate that the microbial composition of the overburden will considerably impact the soil gas composition. Thus, to improve the understanding and the utilisation of soil gases for mineral exploration, gaining a better understanding of the geomicrobiology of the overburden is crucial.