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CO2 production by mechanical stress on carbonate rocks and its implications for natural hazards assessment

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The distribution of known CO2 discharges generally coincides with the on-land segments of major linear zones of seismicity throughout the world, showing the strong correlation between natural degassing and earthquakes. On the other hand, aftershocks of large earthquakes have been attributed to the coseismic release of trapped, high-pressure CO2-dominated fluids propagating through damaged zones created by the main shock thus underlining the role of the fluids as "agents" able to generate overpressures and reactivate fault segments inducing earthquakes.

Recent experimental results have demonstrated that CO2 can be produced by mechanical stress applied on carbonate rocks sometimes requiring a relatively low energy amount. As a result, crustal volatiles can be produced due to high-pressure, mechanical stresses at moderate levels within the crust. Experiments, whereby different types of carbonate rocks (natural and synthetic) have been milled, have shown that carbonates release CO2 systematically and reproducibly leaving little doubt that carbonate rock located in shallow parts of the crust may undergo structural break-down to form CO2, particularly in the presence of accessory phases such as clays. Such a process allows several natural systems (e.g. active faults in limestones) to become significant CO2 producer when mechanical stress is applied.

The possibility of assessing the linkage between variations in geochemical tracers and the onset of seismic activity, is a topical research activity of meaningful societal relevance and contributes to understand some processes related to the seismogenesis, thus to the largest natural hazard for the humankind. As such, monitoring CO2 over seismic-prone areas located in carbonate rocks, may provide a better insight of the development of the seismogenic process and useful tools in understanding the response of volatiles to crustal perturbations. Moreover, since crustal deformation can also occur aseismically, and rock deformation may produce CO2 as a response to the applied mechanical stress, monitoring of CO2 discharges could be useful in the estimate the probability increase of an impending earthquake in a potentially hazardous seismic region. Laboratory results and field investigations carried out over the seismic-prone area of the Central Apennines provided the first results useful for practical applications in facing the natural hazards related to both seismic activity and release of hazardous gases.