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Mechanochemical origin of carbon dioxide from sedimentary rocks

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Many studies on the natural sources of the greenhouse gases, such as carbon dioxide and methane, have been carried out in fields of geological and geochemical research with the aim to study the contribution of these gases to the Earth atmosphere. CO2 emissions are generally attributed to mantle degassing, organic activity or degassing due to thermometamorphic processes of limestones. However, field observations demonstrate that a large amount of CO2-rich gases are emitted over tectonically active areas where the contribution from the mantle is weak or absent. Focusing the attention on those emissions, our main target is to provide new tools to evaluate the genesis of such natural gas phase. Using the mechanochemical approach, laboratory milling experiments carried out on solid carbonate samples highlighted that a large amount of CO2 was produced under the application of mechanical stress. The analyses demonstrate that shear stress application on carbonatic samples leads to dissociation of the calcium carbonate crystalline lattice with CO2 separation and amorphous CaO production. The formation of a new mineralogical phase, aragonite, the high-pressure calcium carbonate polymorphous. The mechanochemical origin can be considered as another important source of natural CO2 that can be produced during shear stress driven by tectonic activity involving carbonatic rocks. This mechanism provide a possible explanation with respect to the origin of CO2 in all of those tectonic areas where the venting CO2 and deep-located CO2 reservoirs are associated to high helium content marked by radiogenic-derived values that clearly reveal the absence of any contribution from the mantle as a source for the released gases.