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Global-scale correlation between CO_2 earth degassing, major faults, tectonic regimes and heat flux: a review and update

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Earth degassing of non-volcanic CO_2 has been proven to contribute significantly to the global carbon budget. The origin of this carbon is a mix of mantle and crustal-derived components. The presence of such degassing activity can be easily revealed at a regional scale through the study of CO_2-rich aquifers that have sequestrated the gas exhaled from the deep source. At a global scale, the presence of ubiquitous outgassing reveals a certain degree of permeability of the crust in some areas that often coincide with seismically active zones. In this study, we took advantage of the most recent global geological datasets to better understand the earth degassing and how it correlates with active faults, seismic regimes, surface heat flux and aquifer volumes. The Global Earthquake Model project offered a dataset of active faults and their slip typology. Using an ad-hoc point pattern analysis, we show that there is a spatial correlation between CO_2 discharges and the presence of active fault systems, in particular with those characterized by a normal slip type. Seismic data obtained from the Global CMT Catalog demonstrates also the existence of a positive spatial correlation between gas discharges and extensional tectonic regimes and confirms that such processes would play a key role in creating pathways for the rising gases at a micro- and macro-scales, increasing the rock permeability and connecting the deep crust to the earth surface. A comparison with global surface heat flux values also shows that the majority of gas discharges occur in areas with higher heat flow ($> 60mW \cdot m^{-2}$). Finally, the global distribution of groundwater suggests that there are arid regions in the world, characterized by high heat flows, active faults and extensional seismicity, that could potentially manifest earth degassing phenomena never or poorly studied via gas-trapping aquifers. The only way to study such areas is by mapping CO_2 diffuse degassing at a local scale with time-consuming point measurements (e.g. accumulation chamber).