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A worldwide catalogue of natural CO_2 and CH_4 surface leakages: An approach on undesirable geological contexts for CO_2 storage, taking into account strain rate, stress, and tectonic regime.

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Recently, CO_2 storage has become one of the most effective ways to counteract greenhouse gas emissions and contribute to the global carbon neutrality agreement. To ensure containment, it is important to know how geological layers surrounding the targeted reservoirs will serve as a seal to injected fluids, in particular where the overburden and reservoirs are affected by faults. One of the main controlling factors for gas leakage is through fault networks. Studying worldwide areas of natural gas emission is therefore useful in understanding the risk of potential gas leakage associated with CO_2 storage. From a range of geological scales, reviewing cases of natural gas leakage through in-house and published datasets, can help us understand the various geological factors which influence a region to be more or less susceptible to vertical fluid escape. In this study, a review of CO_2 and CH_4 (Methane) surface leaks is mapped using Geographical Information Systems (ArcGIS Pro). Moreover, a relationship between CO_2 and CH_4 leakages and the global strain map, stress map, heat flow maps, and world lithologies is generated. Strain rates and deformation styles are based on the global strain rate map of Kreemer et al. (2014). Plate boundary zones are defined and categorized into extensional, transtensional, strike-slip, transpressional and compressional settings. Deformation styles associated with these categories are represented between values 1 and -1 respectively. Furthermore, numerical values of the strain rate are divided into three classes: high, low, and negligible deformation rates. Stress regimes independently derived from the world stress map dataset (Heidbach et al., 2018) are generally consistent with deformation styles in the high and low deformation rate zone and provide additional constraints in the plate interiors. Our results indicate that high strain rates are not a necessary condition to leakages. CO_2 leakage is generally concentrated around regions with high volcanic activity, hydrothermal and geothermal area within zones of extensional regimes such as normal and transtensional strike-slip faulting whereas CH_4 leakage is more commonly associated with oil and gas seeps, mud volcanoes, and other gas vents such as mofettes within zones of transpressional regimes or reverse faulting. Both CO_2 and CH_4 leakages can be present in a few sedimentary basins, generally of extensional origin which experienced reactivation of normal faults.

References

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