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Recognition of buried fault and/or fracture by soil gas method: an example in southern Taiwan

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Taiwan is located on the boundary between Eurasia plate and Philippine Sea plate. The continuous stress and collision make Taiwan densely faulted. Therefore, to find out the distribution of active faults requires urgent attention for disaster mitigation. So far most of the research has been based on geophysical techniques, trench studies and structure geology. Nevertheless, geochemical methods were rarely used in Taiwan. In this work, the soil-gas compositions are measured and synthesized to compare with the geological, geophysical and geomorphological information along the Chao-chou Fault, which is considered to be as an active fault in southern Taiwan.

The soil-gas method on the principle that faults and/or fractures are conduits may provide high permeability pathways through rock, gases will migrate upward through faults and/or fractures from deep crust or mantle which produces anomalously high deep source signatures in the soil above. This method is very useful as it gives result in short time and at low cost.

More than 500 soil-gas samples were collected along several traverses crossing the observed structures and analysed for He, CO_2, CH_4, Ar, O_2 and N_2. Comparing the structure lines based on the variation of helium and carbon dioxide concentrations in the soil, it has been found that both there are conformity with distribution and indicating N-S trend. Hence, helium and carbon dioxide are very useful index gases in this work. The results show that helium and carbon dioxide concentration in the soil gas reveals anomalous values for specific positions along each of the traverses. It indicates N-S trending faults and/or fractures which correspond to the reported trend and pattern of the Chao-chou Fault in southern Taiwan.

Moreover, helium isotopic compositions of representative samples are from 0.93 to

1.05 Ra ($^{3}He/^{4}He$ ratio of air), which illustrates that most samples are having soil air components but there is no significant input of mantle component. Carbon isotopic data of representative soil samples are from -10.35 to -23.44 permil. Most of data fall in the range of organic source, which also elucidated that soil gases are mixed air with shallow component. Continuous monitoring indicates that soil gas variations at fault zone are closely related to the local crustal stress and hence, is suitable for further monitoring.