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多重のデータセットを考慮したベイズ統計学による未知の活断層の評価
A Bayesian approach to assess the probability of concealed active faults existing from multiple datasets

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Assessing the stability of the geological environment including the spatio-temporal distribution of active faulting is of particular concern in the context of site selection of nuclear facilities such as radioactive waste repositories and nuclear power plants.

In order to assess the spatio-temporal distribution of active faults, one typically starts by looking at mapped active faults (e.g. AIST's active fault database) to estimate spatial frequencies and orientations. However, active faults listed in current databases do not represent a complete picture of active faulting, as not all active faults have a surface rupture, and their existence might be unknown. In this case, additional datasets are needed that may imply the existence of active faulting.

Datasets such as high He-3/He-4 ratios which tend to be found in volcanic regions have been attributed to degassing from the mantle with faults potentially acting as conduits. Studies carried out in the western Tottori district have shown the potential of using He-3/He-4 ratios as a means of providing indirect evidence of the existence of source fault(s) that caused the 2000 Western Tottori earthquake, but which had no apparent surface indication prior to the earthquake (e.g., Umeda and Ninomiya, 2009). Other factors that may need to be taken into account when assessing the existence of active faults include horizontal stress orientation, change in stress regimes, regional stresses and so on.

The Bayesian approach can be used to construct probabilistic models from multiple datasets in order to assess the likelihood of given natural phenomena occuring over defined time periods. This method has previously been applied to assessing future new volcano formation (e.g. Martin et al., 2004, 2012) but not to new active fault segment formation. We have thus been developing such a Bayesian model in the Western Tottori district as a case study. In the first step, known active faults are divided into equal fault segments. We assume that unknown fault segments do not exist far from known fault segments. Also, the probability of unknown faults existing decreases with distance from the known faults. 2-D *a priori* probability distributions are calculated using kernel functions centered over the fault segments with varying values of standard deviation depending on the degree of conservation required. A Cauchy probability density function (PDF) is assigned conservatively as the kernel function in the first step so that probability is never zero.

In the second step, Kolmogorov-Smirnov statistical tests are used to remap additional datasets (e.g. He-3/He-4, horizontal stress orientation) into a likelihood PDF. The *a prior* PDF from the first step above is then combined with the likelihood PDF using Bayes' rule to produce a *a posteriori* PDF. In the third and final step, the *a posteriori* PDF is evaluated by comparing probability maps calculated from datasets before and after the 2000 Western Tottori Prefecture earthquake.

The whole procedure can be repeated as new information/data becomes available where the derived *a posteriori* PDF from the first cycle is then used as the starting point, i.e. the *a prior* PDF in the next cycle.

References

AIST, Active fault database of Japan, https://gbank.gsj.jp/active-fault/index_gmap.html
Martin et al. (2004) J. Geophys. Res., 109, B10208, doi:10.1029/2004JB003201.
Umeda, K. and Ninomiya, A. (2009) Geochem. Geophys. Geosys., 10, Q08010, doi:10.1029/2009GC002501.
Martin, Umeda and Ishimaru (2012) InTech Pub., doi:10.5772/51859

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