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Understanding the Requirements of Geology in Earthquake Hazard Assessment from the Perspective of Seismic Source Modellers and Hazard Users

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The role of geology in earthquake hazard analysis at local, national and regional scale has grown significantly in recent decades. As the primary methodology for estimating the level of shaking to which a structure, or portfolio of structures, may be subject within a given time-frame, probabilistic seismic hazard assessment (PSHA) remains the means by which active fault geology informs our strategies for mitigation of earthquake risk. Commonly, this takes the form of design ground motions in seismic building codes; however, this same information is a fundamental input to models of earthquake losses within the insurance industry. As a consequence, it is the earthquake rupture forecast, i.e. the enumerated set of possible ruptures occurring on a given fault and their associated probabilities of occurrence, that is of critical importance to users of seismic hazard and risk analysis.

In 2014, at the end of its first implementation phase, the Global Earthquake Model (GEM) delivered four key products to facilitate an the understanding and incorporation of active faults into seismic hazard and risk analysis: i) the Faulted Earth database of neo-tectonic faults, ii) the hazard modeller's toolkit (a suite of tools for the construction of seismogenic source models for input into PSHA), iii) the OpenQuake-engine software for the calculation probabilistic seismic hazard and risk, and iv) a harmonised, and growing, database of national and regional seismic hazard models. Nearly two years hence, we reflect on these outputs, describing not only how they can linked together to bring active faults directly into seismic risk assessment, but also the challenges that have been faced in the development process, and the current limitations both in the products themselves and in the broader role of geology in seismic hazard.

We will also focus upon on several merging developments in the field of seismogenic source modelling for PSHA, and their potential implications for seismic hazard and risk modellers. These include the recent Uniform California Earthquake Rupture Forecast version 3 (UCERF3) and the 2014 National Seismic Hazard Maps for both the United States and Japan. Within these models we begin to see geodesy and tectonic modelling taking a more prominent role, and a potential need to redefine the probabilistic framework to take into account interdependencies between multiple sets of ruptures within the earthquake rupture forecast. From this overview of the usage active faults in seismic hazard and risk assessment, we consider the information that will be needed from earthquake geologists in the coming years. We will highlight some of the key practical issues facing the earthquake hazard and risk modelling community, including completeness of fault data sets and reconciliation of geological, tectonic and seismological information.