Brittle-Ductile Interaction Hypothesis and Its Physical Model by Time Series Analyses of Earthquake Source Parameters

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One can observe deterministic seismogenic processes evolving into large earthquakes (EQs) by the time series analyses of EQ source parameters collected from a catalog (Takeda, Japanese patent 2003. Takeda and Takeo, AIP Conf. Proc. 2004). The observation has been successfully applied to a short-term deterministic forecasting of large EQs in Japan since 2003 at www.tec21.jp. A key to the observation is to use magnitude Mc of about 3 to 4 corresponding to the unique size of fractures (Aki, EPS 2004), by which one can detect a subtle departure from the self-similar seismicity to dominate the brittle part of the earth lithosphere. Proposed is a physical model to describe how major EQs are deterministically generated. It is the progress of the brittle-ductile (B-D) interaction hypothesis proposed by Aki and Jin.

Aki left us his extraordinary physical insight to grasp the EQ complex phenomena leading to the B-D hypothesis in his lecture note, Seismology of Earthquake and Volcano Prediction, 2003. He also left me encouragement to my EQ prediction work and many supporting comments on my discovery of only two distinct types of EQ precursors, one for the 1995 Kobe EQ (CQK) and another for the 2000 Tottori EQ (CQT), in his 30 emails over a short period of two months in early 2005. Some of his views on my time series analyses with respect to his are the following.

Jan 27, 2005
Dear Takeda - san:
My excitement continues from reading your paper.
First, you do not seem to be bothered by the 60 - event periodicity, attributing it to some process at the brittle-ductile transition zone. Seismologists would react with the suspicion that some artifact in analysis causing it, and discredit your finer interpretation as your imagination. I am amazed in your confidence as a physicist that such fluctuation can be expected as a physical phenomenon. Personally I believe that this periodicity is real, indicating a clear departure of the process involved from the self-similarity, possibly due to the unique size of the fractures in the brittle part of the lithosphere (a few hundred meters to about a km) that I have proposed since the 1989 JGR paper with Anshu Jin. There are numerous observations supporting the existence of such a unique length as I described in my Trieste lecture note, but I still cannot prove it. For example, as you find in the fluctuation of coda Q and N(Mc) in California by Jin and Aki (as quoted in my 2004 EPS paper), we saw a periodicity of about 10 years. The fluctuations in these parameters in other areas are usually several years, much longer than what you showed in your figures. So there must be some artifact in the apparent periodicity that needs to be clarified before convincing seismologists about their physical reality.

Secondly, your distinction of CQT (T for Tottori) and CQK (K for Kobe) is extremely interesting because the high resolution map of coda Q obtained from the 1000 Hi-net stations and the map of N(Mc) from the JMA data both obtained recently by Anshu also identify the two areas not only as anomalous, but also in distinctly different ways. I have not digested fully these observations, but I feel that both you and Anshu are detecting the common phenomenon through different windows. Would you two exchange papers and start communicating each other? There is not much time left, because Anshu must quit her position at NIED at the end of March, as I mentioned in my earlier mail.

Have you read the extended abstract of my paper titled –A perspective on engineering application of seismology– presented at an international symposium organized by the Society of Exploration Geophysicists (SEG), Japan, which I asked Anshu to mail a copy? I have a feeling that my dream about the future of earthquake prediction described in that paper may be realized by you. Perhaps that was the intension of someone in the heaven who arranged several accidental meetings between you and me!

With best regards,
Kei