Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

SEM036-P09 会場:コンベンションホール 時間:5 月 26 日 10:30-13:00

台湾車籠埔断層掘削計画試料の熱履歴の古地磁気解析
Paleomagnetic thermal history of faulting: constraints from the Taiwan Chelungpu-fault Drilling Project

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The September 21, 1999, the Chi-Chi earthquake (Mw = 7.6) attacked Taiwan. The Chelungpu fault caused this earthquake, and fault type is a thrust fault with left-lateral component. In the southern part of the fault, ground accelerations were higher, even though the ground velocities and displacements were less than the north at Chi-Chi earthquake (Chung and Shin, 1999). To understand faulting mechanism of the Chi-Chi earthquake, the Taiwan Chelungpu-fault Drilling Project (TCDP) was conducted to obtain shear zone samples at depth. Two cores called as hole A and hole B were drilled and three different shear zones were found in these boreholes.

Many studies to investigate the faulting history of the active Chelungpu fault have been reported, e.g., in-situ temperature measurements by using borehole (Kano et al, 2006); measurements of compositions of elements and isotope ratios (Ishikawa et al., 2008); thermomagnetic analyses (Mishima et al., 2006). These studies imply that these signatures are attributed to the latest event of faulting (i.e. Chi-Chi earthquake), on the other hand this active fault has been activated many times since 0.7 Ma (Chen et al., 2000). Therefore there is a contradiction for the timing of the earthquake occurrence. Electron spin resonance (ESR) signals are also in turn used to reconstruct the temperature rise of frictional heat (Fukuchi, 2003). Although their methods could apply to the estimation of a single event of temperature rise, they give little information for thermal history and its timing on repetitive frictional heating of the active fault. Additionally, ESR is generally accepted as effective dating method, and has been used for fault gouge dating (Fukuchi, 2001; Murakami et al., 2002). However, ESR dating age does not always mean the age of the latest fault movement, because frictional heating not always reach high-temperature to reset ESR. Here, I conducted systematic paleomagnetic analysis of fault zone rocks of TCDP hole B to trace faulting history of the Chelungpu fault. Remanences are very sensitive to feeble thermal changes, therefore it could be useful to trace the thermal history of repeated faulting by thermal demagnetizations.

In my previous work, anomalous high remanent magnetizations had been found from fault rock samples around core surface. I reargued these anomalous remanences by comparison between surface and interior of core, and found they are almost of origin from drilling-induced remanent magnetization (DIRM) except for some gouge in the 1136-m fault zone and BM disk samples. The fault gouge should be exposed frictional heating, so that samples without DIRM carry original faulting-induced remanences. To investigate their thermal history, thermal demagnetizations for these samples were conducted and exhibited mostly three remanent components unblocked 580 ℃, 300 ℃ and 250 ℃. Thermomagnetic analyses for these samples yielded that they comprise magnetite and pyrrhotite as remanence carrier. Primary component unblocked at 580 ℃ and secondary components unblocked at 300 ℃ should be carried by magnetite and pyrrhotite respectively, and acquired during each mineral was produced. From time-temperature relation in remanence, tertiary components unblocked at 250 ℃ should be acquired flash reheating about 260 ℃ or 300 ℃ in the case of pyrrhotite or magnetite being magnetic carrier respectively. Since the initiation age of the Chelungpu fault activity is 0.7 Ma within Brunhes normal chron (Chen et al., 2000), faulting-induced TRM acquired in earth field should indicate normal polarity. However remanent components of some gouge and BM disk samples indicate reverse polarity, accordingly, these reverse components might be acquired in excursion events. The youngest excursion with high reliability is at 0.3 Ma, therefore the formation events to yield major fault gouge zones should have dated back to Mono Lake excursion at least 0.3 Ma.

キーワード: 古地磁気, 車籠埔断層掘削計画
Keywords: Paleomagnetism, Taiwan Chelungpu-fault Drilling Project (TCDP)