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Kinematics of Pre- to Syn-orogenic Normal Faulting in Foreland Area, SW Taiwan

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Taiwan is located at the convergent zone between the Eurasia and Philippine Sea plates, and tectonically characterized by an active orogenic belt. Before arc-continent collision, the foreland area in southwestern Taiwan was a rift basin. The latest rift event started in the Middle to Late Miocene. After the foreland basin development began in the Early Pliocene, normal faulting was still active till the end of the Pliocene or the Early Pleistocene. Today, extensional tectonics is still going on in the most distal part of the foreland basin. The causal relationship of the extensional tectonics to the orogeny is still in debate. In order to understand the relationship between foreland basin and normal faulting, we analyzed the kinematics of normal faults, i.e. the time-spatial variation in the slip rate of normal faulting through the transition from the extensional to foreland basin periods.In this study, normal fault systems were analyzed with seismic interpretation, Allan map, or fault plane analysis, D-L profile and T-Z plot.

Normal fault evolutionary history was constructed by the study of normal faults interaction and linkage. Most of normal faults in the study area are characterized by one maximum of slip magnitude in the interior part of a solitude fault plane. The maximum of slip magnitude is not always in the middle part of fault plane but biased to the segment overlapping with the other laterally adjacent fault. However, the summation of D-L plot of two laterally adjacent normal faults indicates maximum of slip magnitude right in the area where two faults are overlapping. Such mode of D-L plot suggests slip transfer from one normal fault to the other. Some D-L plots that show two maxima of slip magnitude may indicate the evolution of linkage between two originally separated faults. Difference between two D-L plots for different formation tops would tell the evolution of fault slip and length.

T-Z plots were made on some seismic profiles with well interpreted formation tops. Most of the plots show two stage of normal faulting of different slip rate, the faster one during the Late Miocene and the slower one during next period till the end of faulting. T-Z plots can also be used to decipher the sequence of initiation of normal faulting, fault tip cutting up to the ancient surface and the uplifting forming Middle Miocene unconformity.

In summary, there are two stages of normal fault development in southwestern Taiwan. In the Middle to Late Miocene, normal faulting was active. The slip rate reduced significantly in the Pliocene period. In the early stage, normal faulting started first on the western side and then gradually shifted to the eastern side of the most part of the study area. Normal faulting was more active in the western part of the study area in the early stage, and gradually transferred to the east. Such evolutionary model can be compared with that of the foreland basin development with back-and-forth shift of the forebulge and give some clues about the relationship between foreland basin development and normal faulting.