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Cenozoic Rift-Drift Transitions in the Hsuehshan Trough, Taiwan: Insights from Detrital Zircon Analysis

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The evolution of the sedimentary basin plays a crucial role in determining the sedimentary provenance of the infill record. During the syn-rift period, active normal faults dominate the extensional mechanism, resulting in a straightforward sediment source primarily derived from local highs. As the post-rift stage ensues, overall thermal subsidence induces the graben to receive sediment from more distant sources. Consequently, the detrital zircon age spectrum manifests as a polymodal age population, indicating a diverse sedimentary provenance. However, prior sedimentary provenance studies in Taiwan have overlooked basin development, concentrating solely on variations in the drainage system. Since the early Cenozoic, the Cathaysia block has been subjected to an extensional regime, giving rise to grabens spanning from the East China Sea and Taiwan Strait to the South China Sea, encompassing the Hsuehshan Trough, which experienced disruption due to arc-continent collision in the late Cenozoic. To deepen our understanding of the source-to-sink history of the Hsuehshan Trough during the Late Oligocene to Early Miocene, we compiled data from previous studies and gathered samples from the extensively studied Waimushan Profile in northern coast of Taiwan. The outcrops at this location document the processes during the syn-rift to post-rift stages of the Hsuehshan Trough. Detrital zircon U-Pb dating by LA-ICP-MS was employed to discern shifts in sedimentary provenance. To comprehensively assess basin evolutionary processes from the syn-rift to post-rift stage, this study compiled detrital zircon dating data from well-explored grabens, for example the Songliao Basin. The data were plotted using the bivariate discrimination model, elucidating the sharpness of the young age peak and the polymodality of the detrital zircon population. This study incorporates eleven samples and 1,314 effective U-Pb detrital zircon dating data points. While detrital zircons within the upper Wuchihshan Formation and Mushan Formation exhibit comparable age spectrum patterns, the Cenozoic peak is distinctly evident only in the Mushan Formation, coinciding with Kungkuan stage volcanism during the Early Miocene. Furthermore, the age population undergoes a transition to a polymodal distribution in the subsequent Taliao Formation and Shihti Formation. Utilizing diverse datasets from corresponding basins, the bivariate discrimination model not only delineates convergent to divergent tectonic settings but also unequivocally signifies the syn-rift, transition, and post-rift stages during basin evolution. By applying this model, the evolutionary history of the Hsuehshan Trough can be characterized through the proportion of younger ages and the dispersive age range. Detrital zircons offer valuable insights into the processes underlying the development of the Hsuehshan Trough, with the lower Wuchihshan Formation displaying a syn-rift signal. The upper Wuchihshan Formation and Mushan Formation represent a transitional stage, while the Taliao Formation and subsequent layers indicate the post-rift stage. This finding aligns with previous studies, although it suggests that the boundary between the syn-rift and transition stages may be older than previously thought.

Keywords: Basin evolution, Hsuehshan Trough, and zircon U-Pb geochronology