Sedimentology and Provenance of Alluvial Fan Deposits, Western Pai Basin, Northern Thailand

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Introduction

The Pai Basin is an intermontane basin located in northern Thailand, where extensive alluvial fan deposits are developed along the western basin margin. These deposits provide important information about sediment transport processes, depositional environments, and tectonic influences along the basin boundary (Tangkulboriboon, W. 2015). However, detailed sedimentological and provenance investigations of the western alluvial fan remain limited. This study aims to examine the sedimentary characteristics, stratigraphy, and sediment sources of the alluvial fan deposits in order to better understand their depositional processes and basin evolution. The study area is situated along the western margin of the Pai Basin in Mae Hong Son Province. The basin is surrounded by mountainous terrain, particularly to the west, where granitic and sedimentary rock units are exposed. Six field stations were investigated along a west-to-east transect across the alluvial fan system in order to evaluate spatial variations in grain size, facies distribution, and sediment composition from proximal to distal zones.

Objectives

The objective of this study is to analyze the sedimentological characteristics and stratigraphic architecture of the alluvial fan deposits along the western basin margin. In addition, petrographic analysis is conducted to determine sediment composition and identify the primary source rocks. The integration of field and laboratory data is used to interpret depositional processes and reconstruct the provenance of the fan sediments.

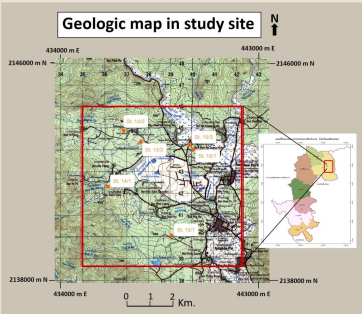


Figure1 Location and geologic map of the study area in the western Pai Basin, northern Thailand. The red box indicates the investigated alluvial fan deposits and measured sections. (modified from Hess, A., and Koch, K. E. 1979)

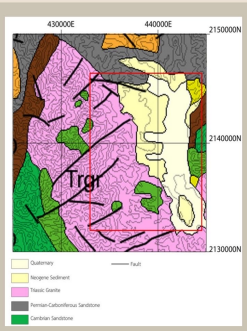


Figure2 Location and geologic map of the study area in the western Pai Basin, northern Thailand (modified from the DMR, 2007)

Methods

This study integrates field investigation and laboratory analysis. Geological field surveys were conducted to document sedimentary structures, lithology, grain size, and stratigraphic relationships. Clast counts were performed in 1 meters at representative outcrops (Jaiinkaew, W. 2022). Stratigraphic columns were constructed to identify facies successions and vertical trends. In addition, thin sections were prepared and examined under a polarizing microscope to determine mineral composition and confirm sediment provenance.

Results

The alluvial fan deposits are predominantly composed of very poorly sorted, matrix-supported gravel. Boulder- and cobble-sized clasts are abundant in the proximal zone near the western margin of the basin. Clasts generally exhibit low to moderate sphericity and range from subangular to subrounded, indicating relatively short transport distances. Toward the medial and distal parts of the fan, the proportion of pebble-sized clasts and matrix increases, while the abundance of boulders decreases. This pattern demonstrates a clear down-fan fining trend from west to east, reflecting progressive energy reduction during sediment transport.

Stratigraphic columns reveal thick gravelly units characterized by massive, matrix-supported textures. Some intervals show upward-coarsening trends and erosional surfaces, suggesting episodic high-energy depositional events. The dominant facies are interpreted as debris-flow deposits in the proximal fan, whereas more stratified sandy units in the medial and distal zones indicate waning stream-flow processes.

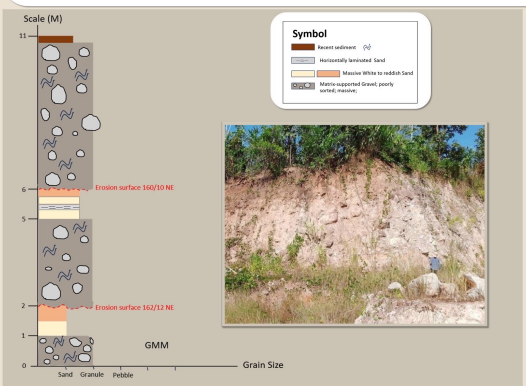


Figure3 stratigraphic section and outcrop photographs of alluvial fan deposits in the western Pai Basin showing matrix-supported gravel (Gmm), massive sand (Sm), and horizontally laminated sand (Sh) with erosional surfaces.

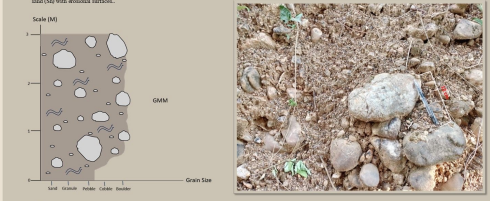


Figure4 Stratigraphic columns and outcrop photographs of alluvial fan deposits in the western Pai Basin showing matrix-supported gravel (Gmm)

Results

Petrographic analysis indicates that clasts are primarily composed of granodiorite, quartz, sandstone, and shale fragments. Thin section observations confirm that the mineral assemblages are consistent with granitic and sedimentary rock units exposed in the mountainous area west of the basin. These findings strongly support a western sediment source and limited transport distance prior to deposition.

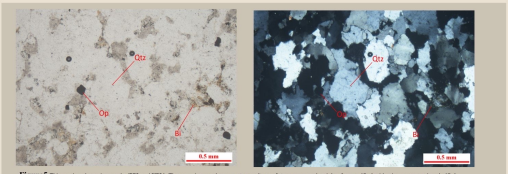


Figure5 Thin-section photomicrographs (PPL and XPL). The upper images show **quartz arenite sandstone** composed mainly of quartz (Qtz) with minor opaque minerals (Op).

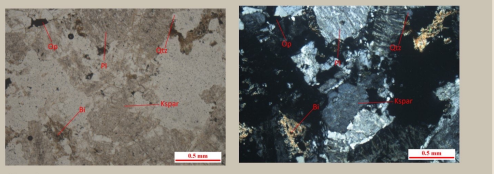


Figure6 Thin-section photomicrographs (PPL and XPL). **granodiorite**, composed quartz (Qtz), feldspar (Pl, Kspar), biotite (Bi), and opaque minerals (Op).

Conclusions

The western alluvial fan of the Pai Basin is dominated by matrix-supported gravel deposits formed under high-energy debris-flow conditions. A distinct down-fan fining trend is observed from proximal to distal zones. Clast composition and petrographic evidence confirm that the sediments were derived primarily from granitic highlands west of the basin. These results provide important insights into sediment dispersal patterns and tectonic influences controlling alluvial fan development in the Pai Basin.

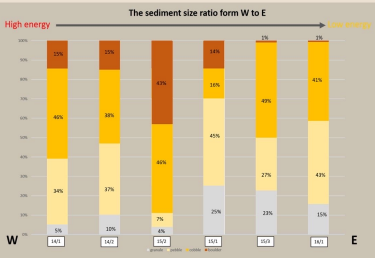


Figure7 Grain-size distribution from west to east across the study area showing a transition from coarse, high-energy proximal deposits to finer, lower-energy distal alluvial fan deposits.

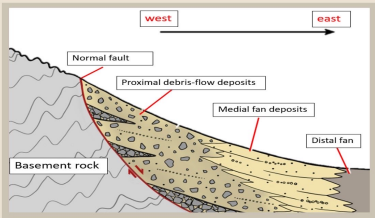


Figure8 Conceptual model of an alluvial fan along the western margin of the Pai Basin showing proximal, medial, and distal fan deposits related to a normal fault.



Figure9 field photograph of the alluvial fan system along the western margin of the Pai Basin, showing proximal debris-flow deposits, medial fan deposits, and distal fan deposits.

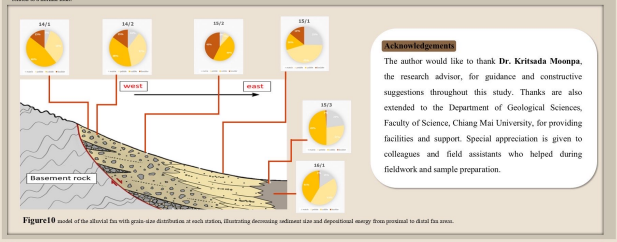


Figure10 model of the alluvial fan with grain-size distribution at each station, illustrating decreasing sediment size and depositional energy from proximal to distal fan areas.

Acknowledgements

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