Identifying paleotsunamis in Thailand using geochemical analyses

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Introduction

Paleotsunami research has received considerable attention following the devastating Indian Ocean tsunami of December 2004. Specific questions involve the magnitude, frequency and impact of past tsunamis.

Phra Thong Island in the eastern Andaman Sea is an ideal location to study paleotsunami deposits in detail (Fig. 1A, B). Apart from the 2004 tsunami layer, three distinct older tsunami layers have been identified and dated (Jankaew et al., 2008). In a collaborative project between Stockholm University and Chulalongkorn University, three sites along a coast-inland transect on Phra Thong Island are currently investigated to assess the extent and impact of these paleotsunamis.

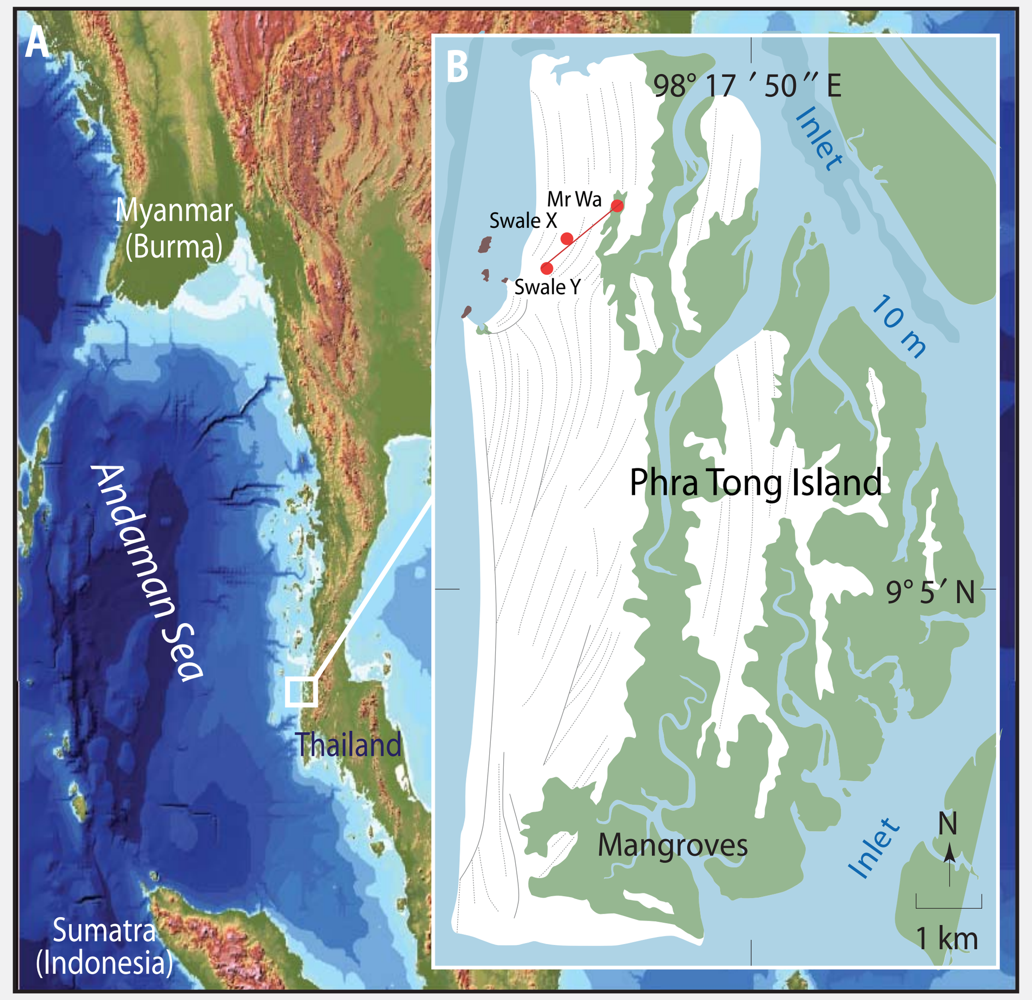

Figure 1A. Location of Phra Thong Island in southwest Thailand. B. Landforms on Phra Thong Island. White areas denote beach ridge plains where the swales are situated. The red line indicates the transect shown in Figure 4.

Figure 2A. Sampling in Swale Y (Picture courtesy S. Björck). B.Swale Y, paleotsunami sand layers can be clearly seen between the darker soil layers.

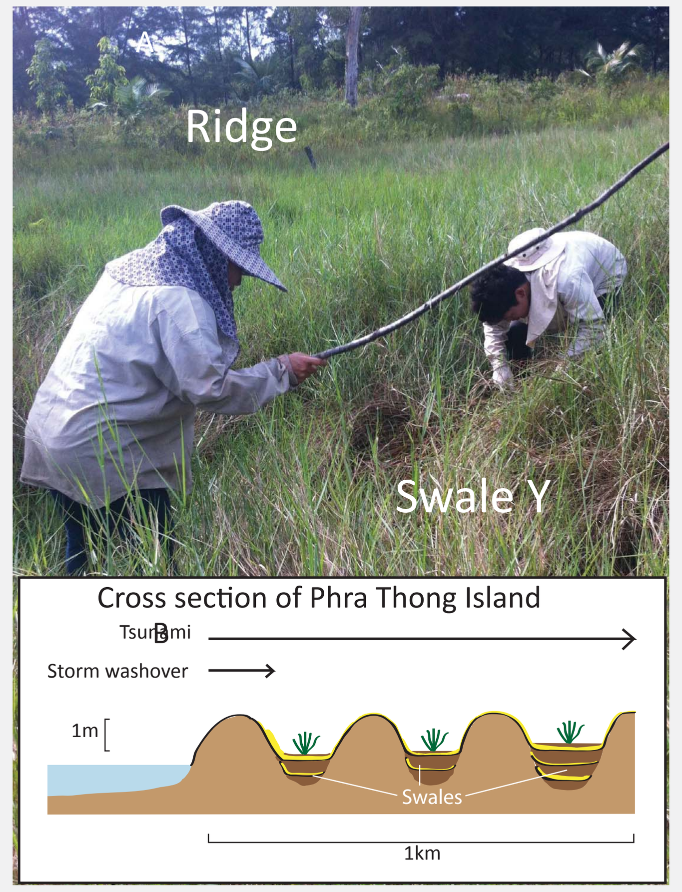

Figure 3A. Swale Y with the ridge in the background. B. This cross section of the Island shows the swales and the ridges.

During fieldwork in January 2013, several box cores and long cores were retrieved from the swales (Figs. 2 and 3). These swales preserve tsunami sand and soil layers very well since they are in contact with groundwater and protected from erosion.

Methods and results

The sediments from swales Y, X and Mr. Wa were chosen for detailed geochemical studies and additional AMS ^{14}C dating. The new ^{14}C dates support the ages assigned by Jankaew et al. (2008). XRF elemental data show a good correlation between individual paleotsunami layers along the transect (Fig. 4, 5). This is further supported by mineralogical data (Fig. 6). LOI values indicate less organic material in the sand layers than in the intercalated peaty soils (Fig. 4). The XRF counts for potassium are high in all sand layers, except for sand D. The reason for these differences is that sand D does not contain the mineral muscovite, which is rich in K (Figs. 4-6).

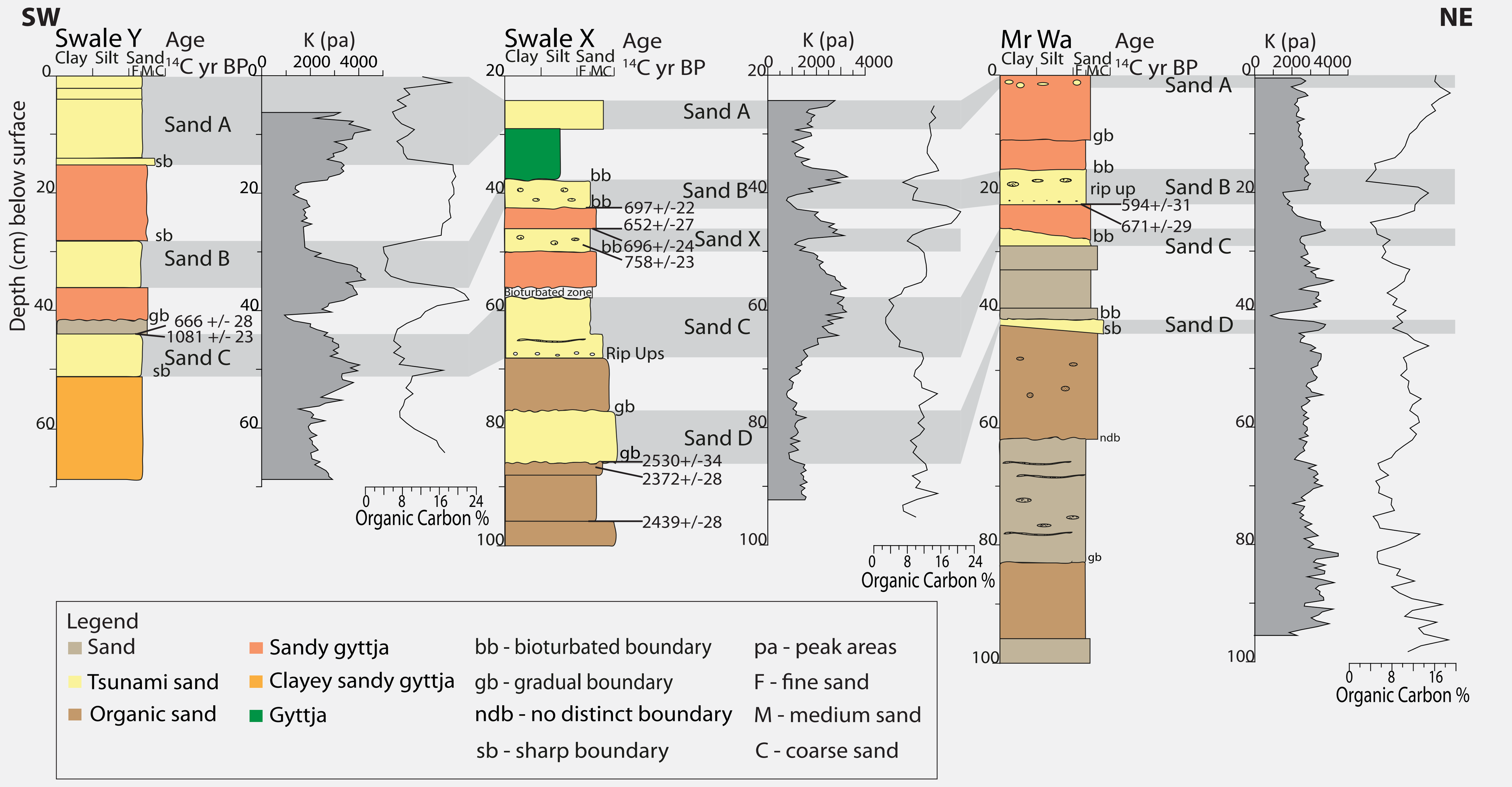

Figure 4. Stratigraphy, K (pa) and LOI values for tsunami sands A, B, C and D and for the intercalated soils along a SW-NE transect. The sampled sediment sequences clearly show three different sand layers separated by dark soils.

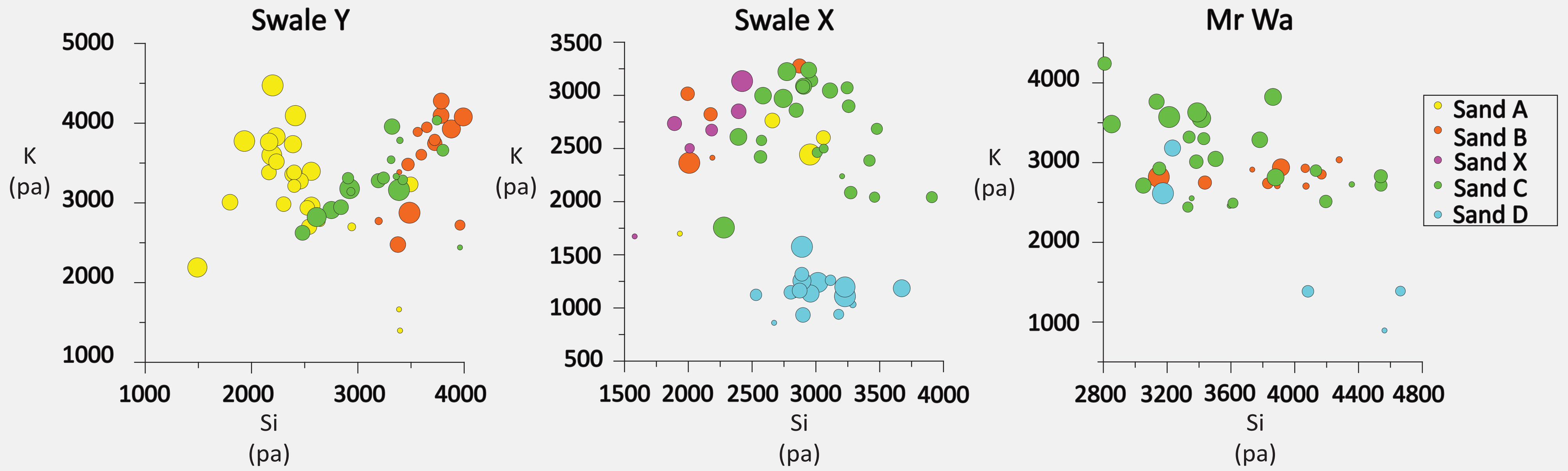

Fig.5. Biplots of Si/K indicate that K values are different in sand D than in the other sand layers.

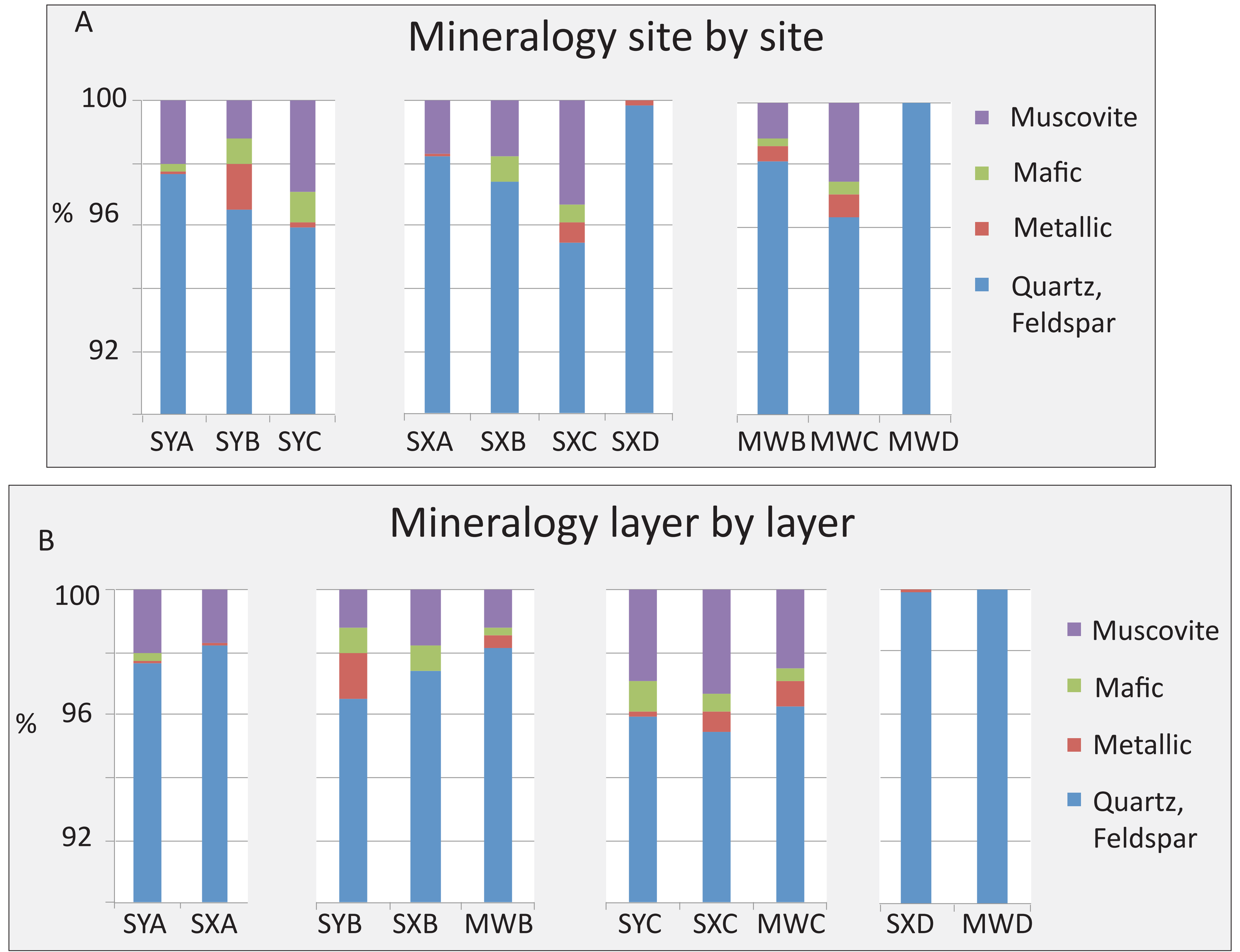

Fig. 6. Muscovite contains potassium (K). The lack of muscovite in sand layer D can explain the low K values. SYA = sand A in swale Y; SYB = sand B in swale Y; SYC = sand C in swale Y.
SXA = sand A in swale X; SXB = sand B in swale X; SXC = sand C in swale X; SXD = sand D in swale X. MWB = sand B at Mr. Wa; MWC = sand C at Mr. Wa; MWD = sand D at Mr. Wa.

Outlook

Future work will focus on a detailed geochemical characterization of the paleotsunami and soil layers to further understand and map the extent of inundation on Phra Thong Island. The low K values in sand D may be due to the fact that its source material is derived from a different location than that of the subsequent paleotsunamis. This needs however further investigation.

References
Jankaew, K; Atwater, B; Sawai, Y; Choowong, M; Charoentitirat, T; Martin, M; Prendergast, A, 2008. Medieval forewarning of the 2004 Indian Ocean tsunami in Thailand. Nature 455, 1228–1231.

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