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Source to Sink Evolution of the Eastern Coast of Indochina: Evidence from Detrital Zircon Geochronology

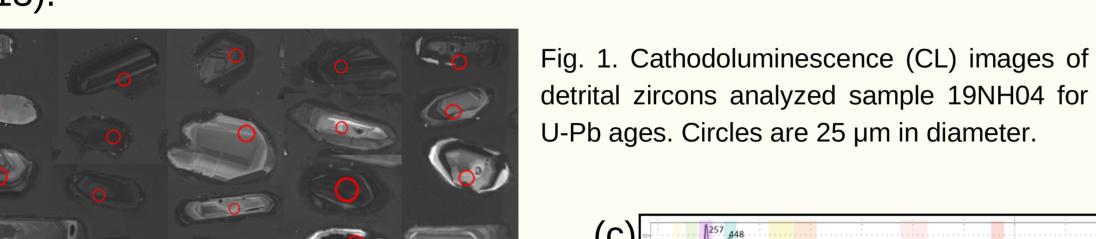


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Introduction

This project focuses on the coastal regions of the eastern Indochina block in Vietnam, featuring over 3,000 km of coastline. 7 beach sand samples were collected and analyzed along with published detrital zircon data in this region. The Red and Mekong Rivers, two of the largest rivers in Vietnam, contrast with smaller catchments in central Vietnam, draining from inland mountains.

These rivers are essential for tracing the source-to-sink pathways of detrital zircon. U-Pb dating of detrital zircon reveals the ages of sediment sources (terranes) and offers insights into past tectonic events (Gehrels, 2011). Using the R programming language, we visualized age spectra through kernel density estimate (KDE) plots (Vermeesch, 2012) and compared sample similarities using IsoplotR's Multidimensional Scaling (MDS) diagrams (Vermeesch, 2013).



Belbu Wan

Fig. 3. A simplified Paleozoic terrane map of Indochina and adjacent areas (modified from Tran et al., 2020).

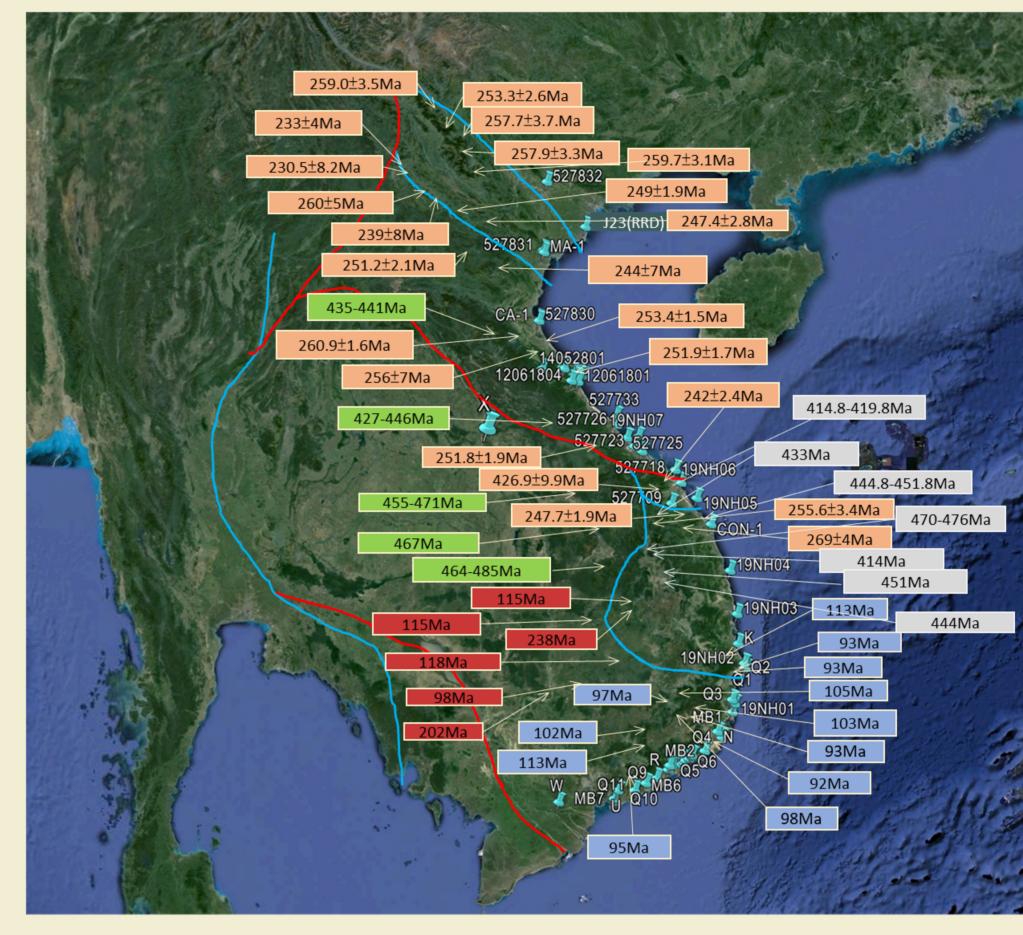


Fig. 4. A simplified eastern Indochina bedrock-age map. Data is derived from Cheng et al. (2019), Tran et al. (2019), Wang et al. (2021), Jiang et al. (2020), and Zhang et al. (2023).

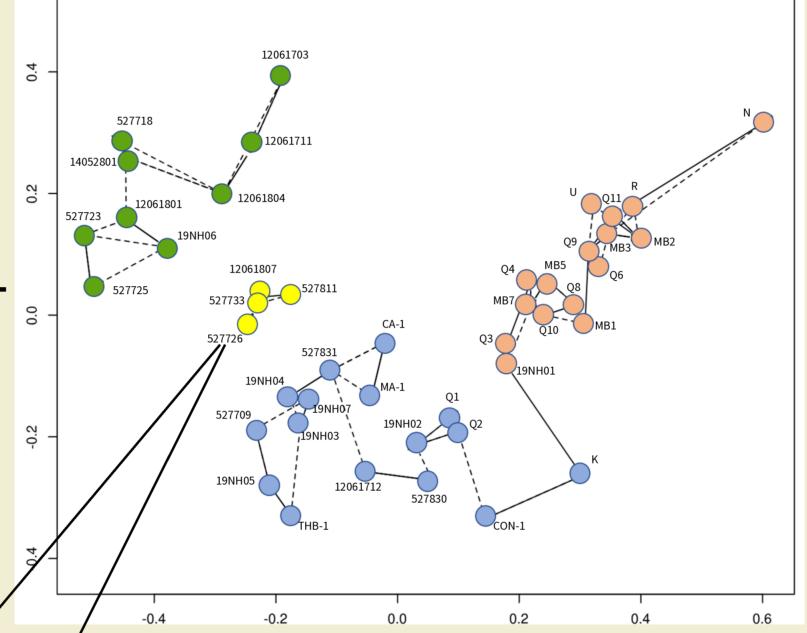
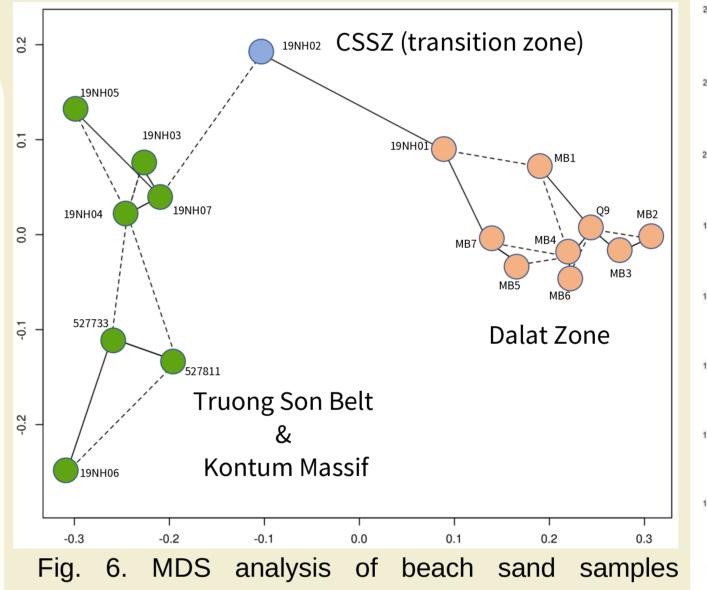


Fig. 5. MDS analysis of all samples (without Red River and Mekong River samples). The MDS map, based on the Kolmogorov-Smirnov effect size (Vermeesch, 2013), groups samples with similar age spectra into three primary categories, roughly corresponding to geographical regions: the North Truong Son Belt (green), Central Kontum Massif (blue), and South Dalat Zone (orange). Additionally, a distinct subgroup within the Truong Son Belt (yellow) is identified due to unique variations in its age spectra. In the KDE plots, samples 12061807 (from Jonell et al., 2016), 527733, 527811, and 527726 (from Fyhn et al., 2019) consistently display a dominant age peak from the Indosinian Orogeny, along with smaller peaks of Proterozoic ages.

Mand sample 527725 (from Fyhn et al., 2019) and beach sample 19NH07 are sand located at similar latitudes and geographically close. However, in the MDS diagram, different into they categories, prompting further investigation into the sediment differences transportation processes between inland areas and coastal beaches.



categorizes them into two main geographical regions

and one distinct sample: the northern group,

associated with the Truong Son Belt and Kontum

Massif (green); the central group, located near the

Chu Sinh suture Zone (CSSZ) (blue); and the

southern group, corresponding to the Dalat Zone

(orange).

Fig. 7. Winter and summer circulation patterns of longshore currents in the eastern South China Sea and monsoon wind directions are also shown (from Giuliani at el., 2019.).



The KDE plot reveals distinct age spectra among the beach sand samples, resulting in their division into three categories on the MDS map (Fig. 6). The sedimentary source of the first group (green) is likely linked to the Truong Son Belt and northern Kontum Massif, the second group (blue) to the area near the Chu Sinh suture zone (transition zone), and the third group (orange) to southern Vietnam's Dalat Zone.

These patterns are likely shaped by longshore currents along the eastern Indochina block (Fig. 7), which redistribute sediments along the northern to central beaches, resulting in the clustering of those samples. In contrast, the southern samples are influenced by tectonic signatures from the Yanshanian Orogeny in the Dalat Zone. However, both the KDE plots and MDS diagrams clearly indicate that the structural demarcations (Fig. 3) did not cause any significant changes.

Fig. 2. (a) Sample locations in northern and central Vietnam as shown on a Google Earth map. (b) Sample locations in southern Vietnam on a Google Earth map. (c)-(e) KDE plots for all samples.

In (c) and (e), Sample J23 (RRD) (from He et al., 2023) and Sample 527832 (from Fyhn et al., 2019) represent the Red River, while Samples X and W (from Nguyen et al., 2018) represent the Mekong River. Both rivers have extensive drainage systems, with their KDE plots showing significant age peaks corresponding to the Indosinian and Caledonian Orogenies, with minor contributions from Proterozoic ages (2500-539 Ma).

The remaining samples predominantly show ages between 300-200 Ma, with a mean peak of around 250 Ma, characteristic of the Indosinian Orogeny. In northern Vietnam, another common age peak at 450 Ma is linked to the Caledonian Orogeny, while in southern Vietnam, samples often display an age peak near 100 Ma, related to the Yanshanian Orogeny in the Dalat zone.

527832 n = 106

J23(RRD) n= 584

527831

527830 n=117

12061703

19NH06 427 470 577 588 788 1070 1502 1777 2290 2480 2791 2850 3190 n=121

印支 加里東 晉寧 四堡 呂梁 an Indosinian Caledonian Jinning Sibao Luliang

Conclusion

- Detrital zircon geochronology is crucial for mapping the source-to-sink pathways within the eastern Indochina block.
- The age spectra of detrital zircons serve as key indicators for identifying different sediment source categories and understanding their origins based on distinct drainage systems.
- In this study, while river drainage patterns predominantly influence detrital zircon deposits, longshore currents also play a significant role in modifying the detrital zircon distributions.
- The age spectra of detrital zircons collected from various beaches are influenced by longshore currents, although these ocean currents are not strong enough to alter the age spectra of samples from southern Vietnam, particularly those near the Dalat Zone.
- The structural demarcations (Fig. 3) have a minor effect on the result of both the KDE plots and the MDS diagrams.

Refrecences