

Increasing extent of the western Patagonian Ice Sheet between 42 and 16 kyr cal BP

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INTRODUCTION

During the Last Glacial Maximum, the Patagonian Ice Sheet (PIS) was the second-largest ice mass in the Southern Hemisphere, after Antarctica, extending across the southern Andes from ~38°S to 55°S. Today, only 5% of the ice mass remains. Late Quaternary reconstructions of the PIS are well constrained on the eastern side of the Andes, but comparatively, the extent and dynamics of its western margin remain poorly known. Here, we use marine sediment core MD07-3119 (46°S) to produce a continuous reconstruction of western PIS extent and behaviour between 42 and 16 kyr cal BP. The sediment core was scanned every 1 cm with an XRF scanner and analysed for a suite of inorganic proxies (grain size, ice-rafted debris [IRD] and bulk mineralogy) to reconstruct sediment transport processes and provenance.

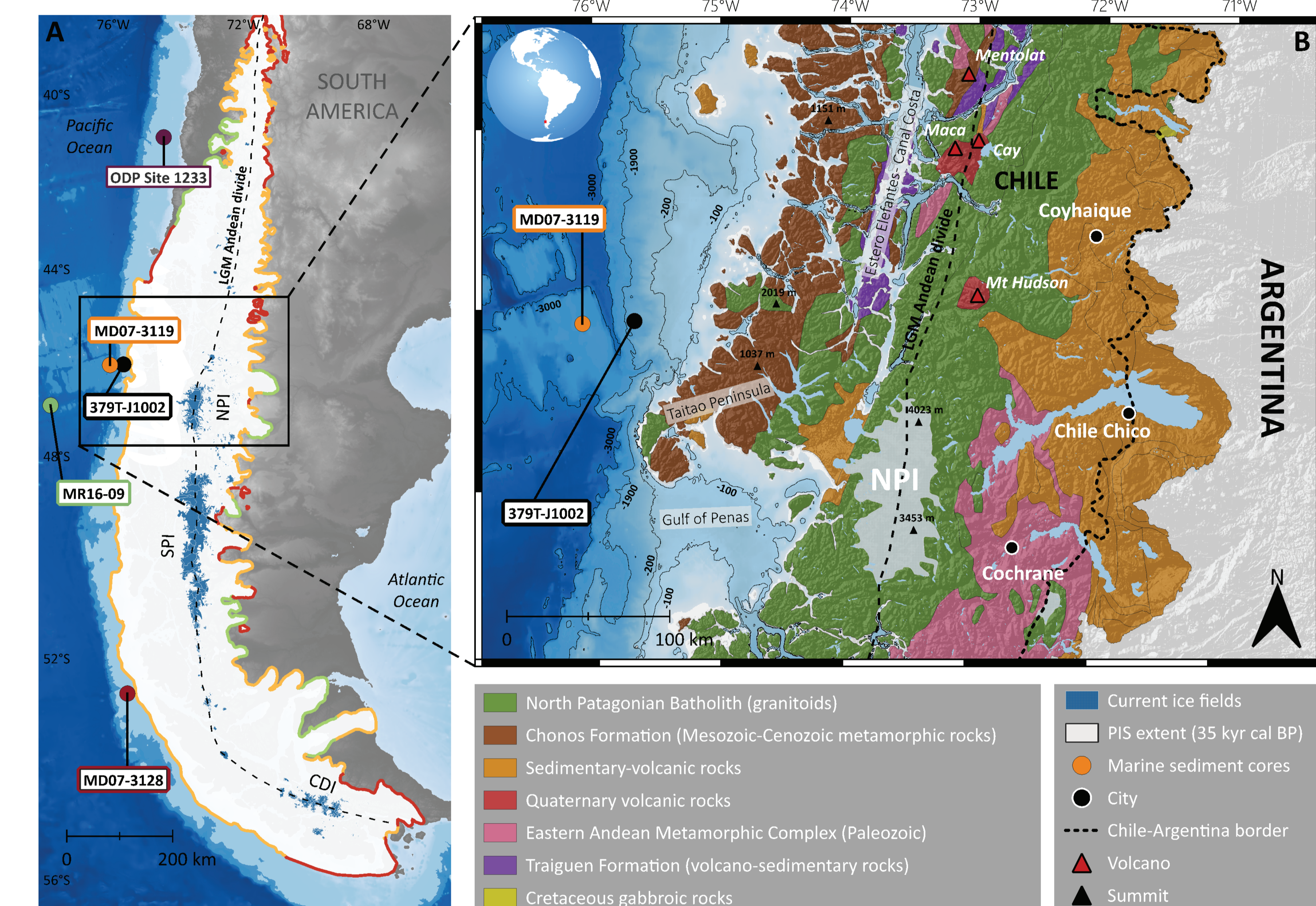


Fig 1. (A) Study area in southern South America showing sediment coring sites, the maximum PIS extent 35 kyr ago, and the current ice fields, inspired by Davies et al. (2020). (B) Simplified geological map of the Northern Chilean Patagonia (B). NPI: Northern Patagonian Icefield, SPI: Southern Patagonian Icefield and CDI: Cordillera Darwin Icefield.

CONCLUSION

Between 42 and 16 kyr cal BP, the western Patagonian Ice Sheet (PIS) advanced and retreated several times. It transitioned from a fragmented system in MIS 3 to a fully coalesced ice sheet in MIS 2 directly reflecting the PIS's sensitivity to temperature.

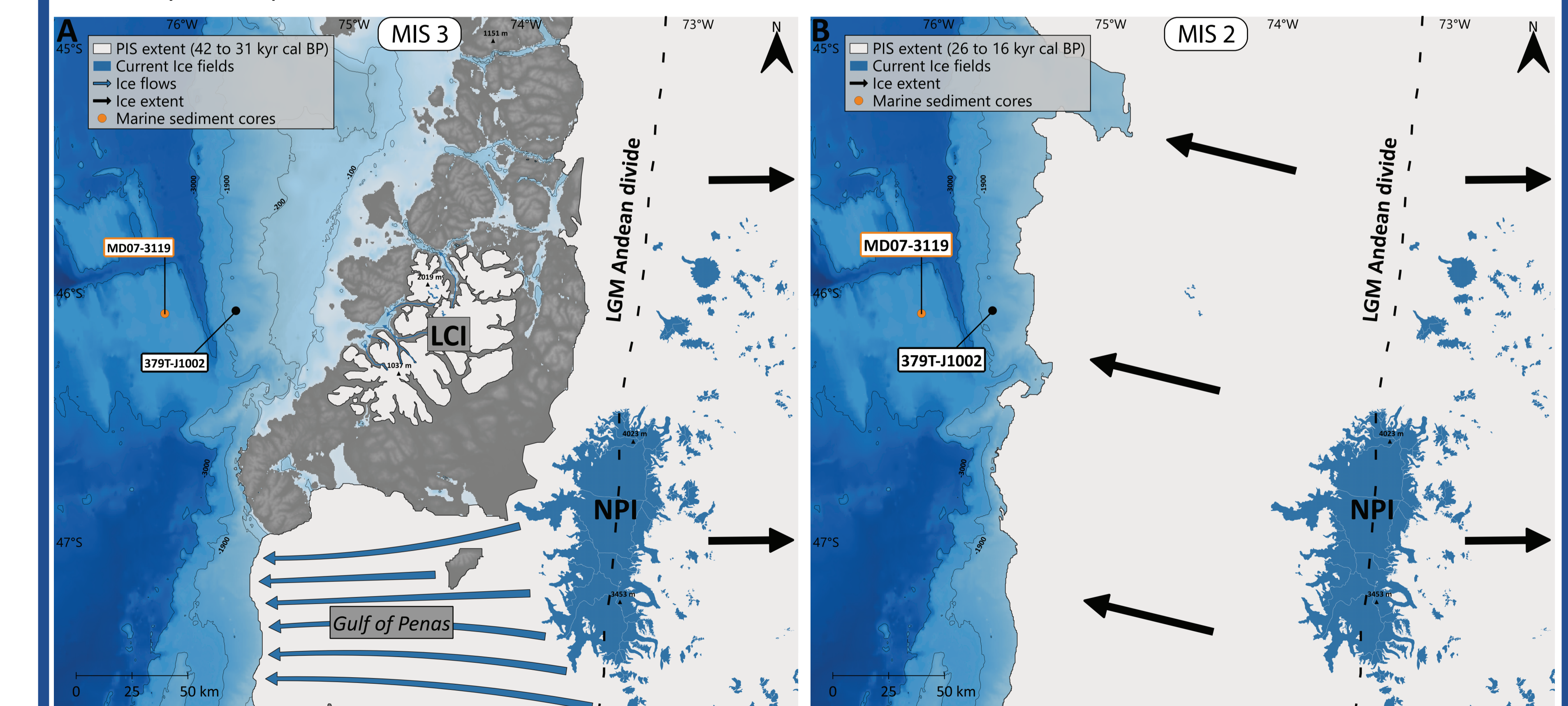


Fig 6. Reconstruction of the western Patagonian Ice Sheet advances between 42 and 16 kyr cal BP. (A) PIS advances from 42 to 31 kyr cal BP, including isolated icefield atop the Taitao Peninsula. (B) PIS advances from 26 to 16 kyr cal BP. NPI: Northern Patagonian Icefield and LCI: Los Chonos Icefield.

DATA

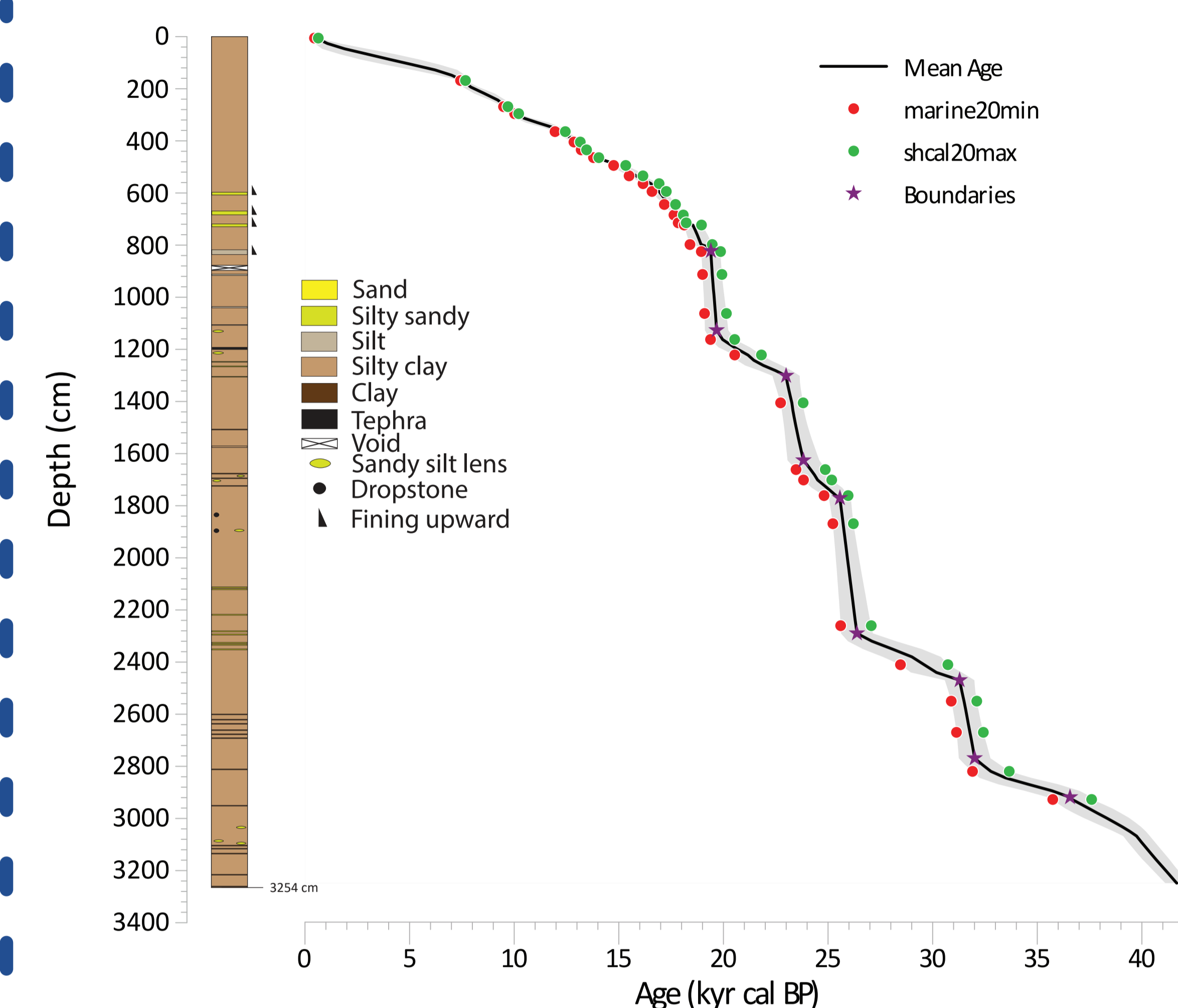


Fig 2. Lithology and age-depth model of the MD07-3119 sediment core produced with Oxcal. Purple stars indicate set breakpoints defined by abrupt changes in inorganic geochemical composition.

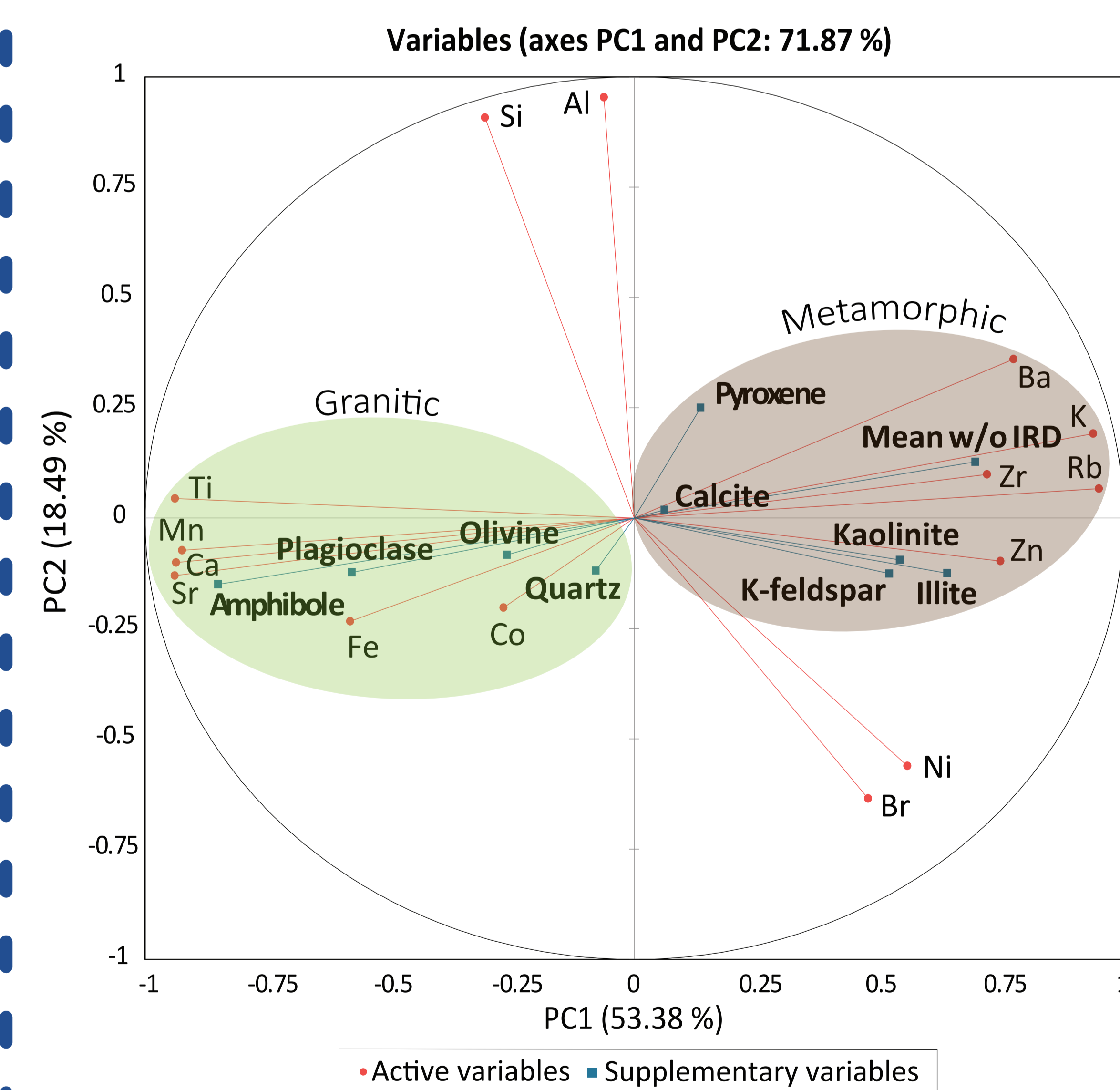


Fig 3. Principal Component Analysis (PCA) of the XRF and mineralogical dataset from core MD07-3119.

INTERPRETATION AND DISCUSSION

Results show that inorganic geochemistry mostly reflects sediment provenance (batholith vs metamorphic bedrocks) in agreement with mineralogical data. Variations in IRD content and sediment provenance from 42–16 kyr cal BP indicate three evolutionary states of the western PIS. First, PIS was discontinuous, calving through the Gulf of Penas with a primary ice stream delivering granitic sediments between 42 and 31 kyr cal BP. Following this, between 31–26 kyr cal BP, the western PIS became primarily land-based; however, unexpectedly coarse, metamorphic sediments from this period indicate the presence of an isolated, localised ice mass referred to as the Los Chonos Icefield. Finally, from 26–16 kyr cal BP, lower sea surface temperatures drove a massive expansion of the PIS over the Taitao Peninsula, characterised by an influx of coastal metamorphic sediments, though this period was briefly punctuated by temporary land-terminating retreats between MIS 2 advances.

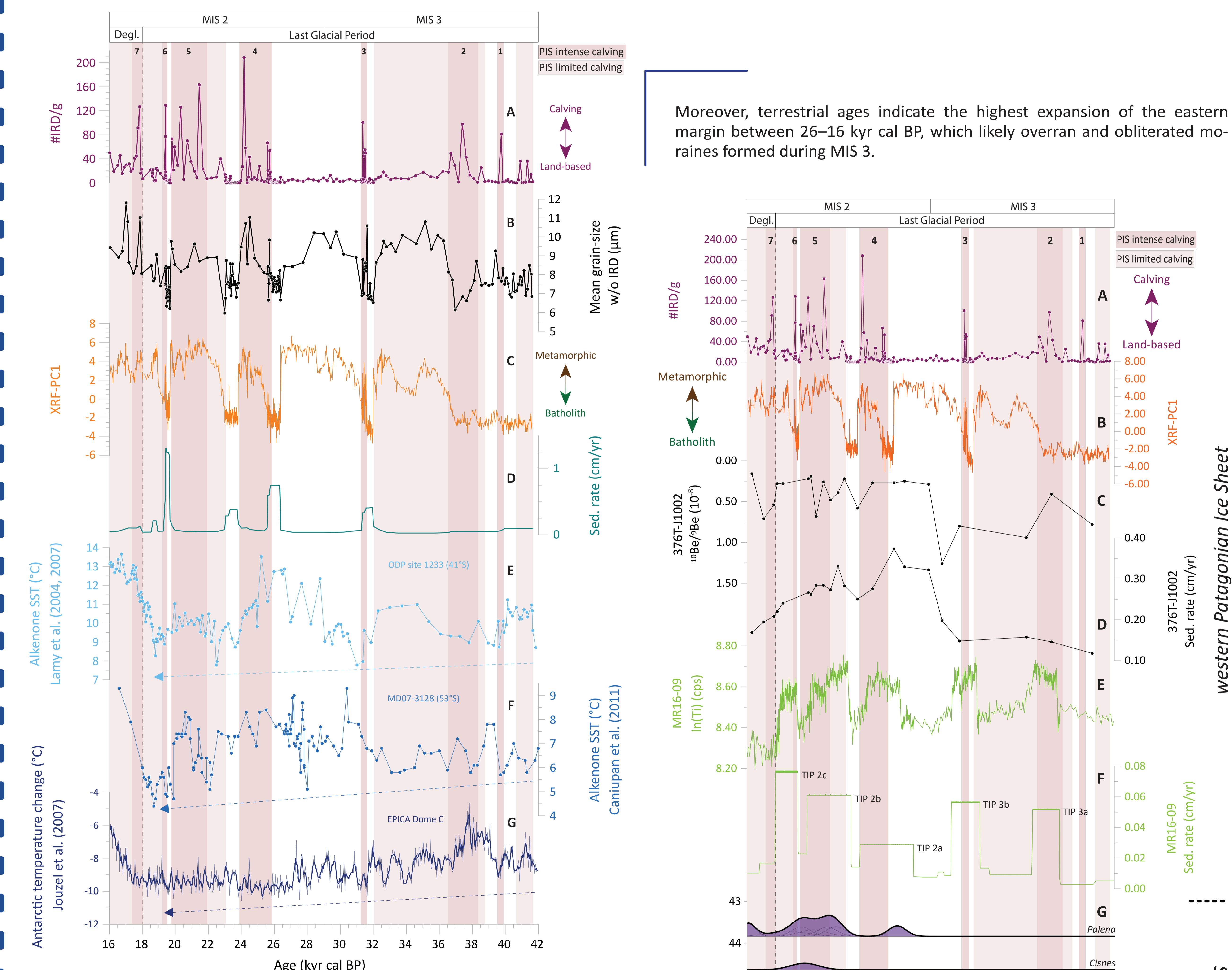


Fig 4. Reconstruction of PIS dynamics over the last 42 kyr based on sediment core MD07-3119. The pink vertical bands indicate the PIS calving intervals defined in this study, based on the MD07-3119 record.

Moreover, terrestrial ages indicate the highest expansion of the eastern margin between 26–16 kyr cal BP, which likely overran and obliterated moraines formed during MIS 3.

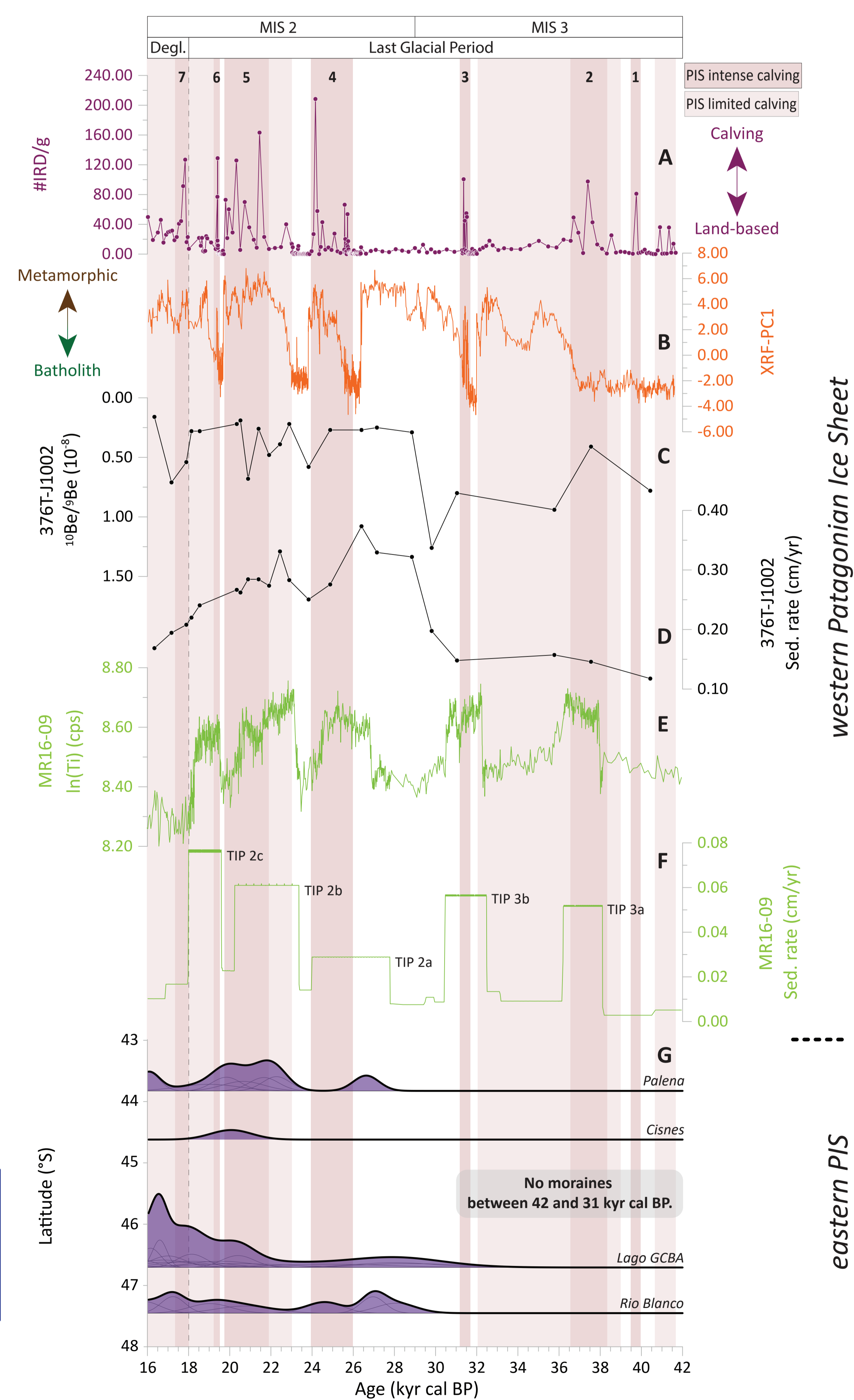


Fig 5. Assessing synchrony in Patagonian Ice Sheet dynamics (42–16 kyr cal BP): A comparison of western marine sediment records (MD07-3119, 376T-J1002, and MR16-09 PC03 cores) with eastern terrestrial glacial geochronology.

