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## Supplemental Material

**Figures S1–S2**

**Data Sets S1–S2**

**Data sources and methods.**

## DATA REPOSITORY

Figure S1: (A) Detrital zircon age distributions and SEM-CL images for zircon samples in this study. Bin width: 20 Ma. (B) Chondrite-normalized REE patterns for zircon samples in this study. Only ages of 250-200 Ma, 190-140 Ma and 140-90 Ma are plotted. (C) Discriminant diagram for zircon samples in this study with continental and ocean crust zircon fields defined in Grimes et al. (2007) and discriminant diagram with contrasting zircon source fields defined in Wang et al. (2012). No correction has been made to the trace element concentrations and the Pb concentration represents total Pb.

Figure S2. Large map: simplified Borneo geological map after Galin et al. (2017). Samples locations for this study are indicated on the map. Small map: simplified tectonic architecture of Proto-Borneo in the Mesozoic after Batara and Xu (2022), showing subduction zone controlled by Proto-Tethys and Meso-Tethys.

Dataset S1. Detrital zircon U-Pb isotopic data

Dataset S2. Detrital zircon Lu-Hf isotopic data

Data sources and methods

## GSA Supplemental Material

### **Data sources and methods to accompany ‘SW Borneo, an autochthonous Pangea-Eurasia assembly proxy: Insights from detrital zircon record’**

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## 36 DATA SOURCES FOR FIGURES

### 37 Figure 1

Data label in Excel	n	Reference
Kuching	129	
Sadong 1	130	Breitfeld et al., 2017
Sadong 2	142	
Pedawan 2	70	
Ngili 3	75	Breitfeld and Hall, 2018
Ngili 4	131	
Karimunjawa 1	107	
Karimunjawa 2	80	Witts et al., 2012
Tambak 2	92	
Kuayan	29	
Ketapang	59	
Bengkayang 1	80	Wang et al., 2022a
Bengkayang 2	71	
Bengkayang 3	79	
Kerabai	90	
Lubuk Antu 1	105	Zhao et al., 2021
Lubuk Antu 2	101	
Lubuk Antu 3	81	
Serabang 3	50	Wang et al., 2021
Serabang 1	78	
Meratus Volc	82	Wang et al., 2022b
Keramaian	69	Kueter et al., 2016

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40 **Figure 2**

Data label in Excel	n	Reference
Lasipu 1	158	Zimmermann and Hall, 2019
Lasipu 3	91	
Lasipu 4	103	
Lasipu 5	128	
Lasipu 6	32	
Seical	141	
Oe Baat 1	132	
Ungar-Upper SST 1	122	
Ungar-Upper SST 2	37	
Ungar-Upper SST 4	131	
Maru 1	111	Zimmermann and Hall, 2016
Maru 2	123	
Maru 3	45	
Maru 4	116	
Maru 5	104	
Maru 6	126	
Maru 7	138	
Maru 8	86	
Niof 1	119	
Niof 2	58	
Niof 3	113	
Niof 4	77	
Niof 5	126	
Babulu 1	130	
Babulu 2	107	
Ungar	123	
Jurassic SST	133	

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## METHODS

### Zircon U-Pb ages and trace elements

We follow the standard density and magnetic zircon separation techniques. Separated zircon grains were mounted on epoxy resin and brought into a high polish. We performed the measuring of U-Pb isotopes and trace elements using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) at the In-situ Mineral Geochemistry Lab, Ore Deposit and Exploration Centre (ODEC), Hefei University of Technology, China. The analysis instrument is an Agilent 7900 Quadrupole ICP-MS coupled to a Photon Machines Analyte HE 193-nm ArF Excimer Laser Ablation system. Selection for analysis was as random as possible to include all grain-size fractions and reduce preference for large zircon grains. The ablation process was done in an atmosphere of UHP He (0.90 l/min), and the He carrier gas (flow rate set at 0.85 l/min) carries the aerosol out of the ablation cell to the plasma torch (after mixing with Ar gas immediately upon exiting). The ICP-MS system is optimized daily to maximize sensitivity on isotopes of the mass range of interest while keeping the production of molecular oxide species (i.e.,  $^{232}\text{Th}^{16}\text{O}/^{232}\text{Th}$ ) as low as possible, and usually <0.3% (Wang et al., 2017).

Our analyses use standard materials 91500 (zircon) (Wiedenbeck et al., 1995) and NIST610 (glass) as an external calibration for the U-Pb ages and trace element contents calculation, respectively (by bracketing each block of 10 unknowns). For quality control, we analyzed Plešovice zircon grains between every 10 unknown samples (Weighted mean  $^{206}\text{Pb}/^{238}\text{U}$  age:  $335 \pm 2$  Ma,  $2\sigma$ ,  $n=38$ , is close to the reported  $336 \pm 1$  Ma or  $338 \pm 1$  Ma,  $2\sigma$  from LA ICP-MS) (Sláma et al., 2008). Each data acquisition starts with a 20 s blank, before a further 40 s analysis time. Routine laser ablation conditions include a spot size of 30  $\mu\text{m}$  in diameter, a repetition rate of 7 Hz and an energy density of 2.5 J/cm<sup>2</sup>. We performed the offline data processing using ICPMSDataCal program (Liu et al., 2010). For filtered data

according to precision (10% cutoff), we use  $^{238}\text{U}/^{206}\text{Pb}$  ages for zircons <1.4 Ga and  $^{207}\text{Pb}/^{206}\text{Pb}$  ages for older zircons (Gehrels, 2011). And for filtered data according to discordance (10% to 30% cutoff), we use the single-grain concordia age (a type of weighted mean between the  $^{206}\text{Pb}/^{238}\text{U}$  and  $^{207}\text{Pb}/^{206}\text{Pb}$  ages) recommended by Vermeesch (2021) for better precision. Our kernel density estimation (KDE) plots with optimal bandwidth were done using IsoplotR (Vermeesch, 2018).

Scanning electron microscope cathodoluminescence (SEM-CL) imaging of the zircon grains was carried out using Tescan-Mira3 at Nanjing Hongchuang Geological Exploration Technology Service Co. Ltd. Through SEM-CL, we observe a high proportion of euhedral to subhedral zircon grains, with only a few rounded (Fig. DR1). The high proportion of unabraded zircon grains makes far fluvial transport doubtful; hence, they are probably mostly derived from relatively local sources. Detrital zircon grains from the samples typically show Th/U values between 1 and 0.1, which suggest that the zircon grains are mostly comparable to magmatic zircons from felsic and intermediate melt (Hoskin and Schaltegger, 2003; Linnemann et al., 2011). Only a limited amount of zircon grains shows Th/U values below 0.1, which may indicate similarity with metamorphic zircon grains. The U content of these analyzed zircon grains are high (average: ~770 ppm, max: ~4000 ppm).

### **Zircon Lu-Hf isotopes measurements**

Concordant zircon grains were selected for in-situ Lu-Hf isotopic analyses. In-situ zircon Lu-Hf isotope analysis was measured at MRL Key Laboratory of Metallogeny and Mineral Assessment, Institute of Mineral Resources, Chinese Academy of Geological Sciences (CAGS), Beijing by using a New Wave UP213 laser-ablation microprobe, attached to a Neptune multi-collector (LA MC ICP-MS). Wu et al. (2006) described the instrumental conditions and data. We used a stationary spot, with a beam diameter of either 40  $\mu\text{m}$  or 55

94  $\mu\text{m}$ , depending on the size of the previously ablated domains. He carrier gas transport the  
 95 ablated sample from the laser-ablation cell to the ICP-MS torch via an Ar mixing chamber.  
 96 Chu et al. (2002) proposed ratios of  $^{176}\text{Lu}/^{175}\text{Lu} = 0.02658$  and  $^{176}\text{Yb}/^{173}\text{Yb} = 0.796218$  were  
 97 used to correct the isobaric interferences of  $^{176}\text{Lu}$  and  $^{176}\text{Yb}$  on  $^{176}\text{Hf}$ . For instrumental mass  
 98 bias correction, Yb isotope ratios were normalized to  $^{172}\text{Yb}/^{173}\text{Yb} = 1.35274$  (Chu et al.,  
 99 2002) and Hf isotope ratios to  $^{179}\text{Hf}/^{177}\text{Hf} = 0.7325$  (Patchett and Tatsumoto, 1981) using an  
 100 exponential law (Albarède et al., 2004). The mass bias behavior of Lu was assumed to follow  
 101 that of Yb, following mass bias correction protocols detailed by Wu et al. (2006). Zircon GJ-  
 102 1 was our reference during routine analyses, with a weighted mean  $^{176}\text{Hf}/^{177}\text{Hf}$  ratio of  
 103  $0.282031 \pm 0.000014$  ( $2\sigma$ ,  $n=36$ ); it agrees with the weighted mean  $^{176}\text{Hf}/^{177}\text{Hf}$  ratio of  
 104  $0.282022 \pm 0.000011$  ( $2\sigma$ ,  $n=56$ ) (LA MC ICP-MS, Matteini et al., 2010).

105 We calculated the initial  $^{176}\text{Hf}/^{177}\text{Hf}$  ratios,  $\epsilon_{\text{Hf}}(t)$  values and model ages using the  
 106 zircon crystallization ages from U-Pb isotope analysis and adopting the decay constant for  
 107  $^{176}\text{Lu}$  and the chondritic ratios of  $^{176}\text{Hf}/^{177}\text{Hf}$  and  $^{176}\text{Lu}/^{177}\text{Hf}$ , which are  $1.867 \times 10^{-11}/\text{year}$   
 108 (Söderlund et al., 2004), and 0.282785 and 0.0336 (Bouvier et al., 2008), respectively. Our  
 109 calculations for the single-stage model age ( $T_{\text{DM1}}$ ) relative to the depleted mantle use a  
 110 present-day  $^{176}\text{Hf}/^{177}\text{Hf}$  ratio of 0.28325 and  $^{176}\text{Lu}/^{177}\text{Hf}$  ratio of 0.0384 (Griffin et al., 2004).  
 111 Calculation of two-stage model ages ( $T_{\text{DM2}}$ ) assumes a mean  $^{176}\text{Lu}/^{177}\text{Hf}$  value of 0.015 for  
 112 the average continental crust (Vervoort and Blichert-Toft, 1999; Griffin et al., 2002).

## 114 **Data processing method**

115 Data is processed according to the detrital zircon age distribution fingerprinting  
 116 method by Barham et al. (2022) via a modified  $\chi^2$ -distribution analysis and definition of the  
 117 10th to 50th age percentile of the detrital zircon populations. Maximum Likelihood Age  
 118 (MLA) is calculated according to Galbraith and Laslett (1993) and Vermeesch (2021) and the



significant age peaks are calculated according to Galbraith and Green (1990). Calculations are done using IsoplotR (Vermeesch, 2018).

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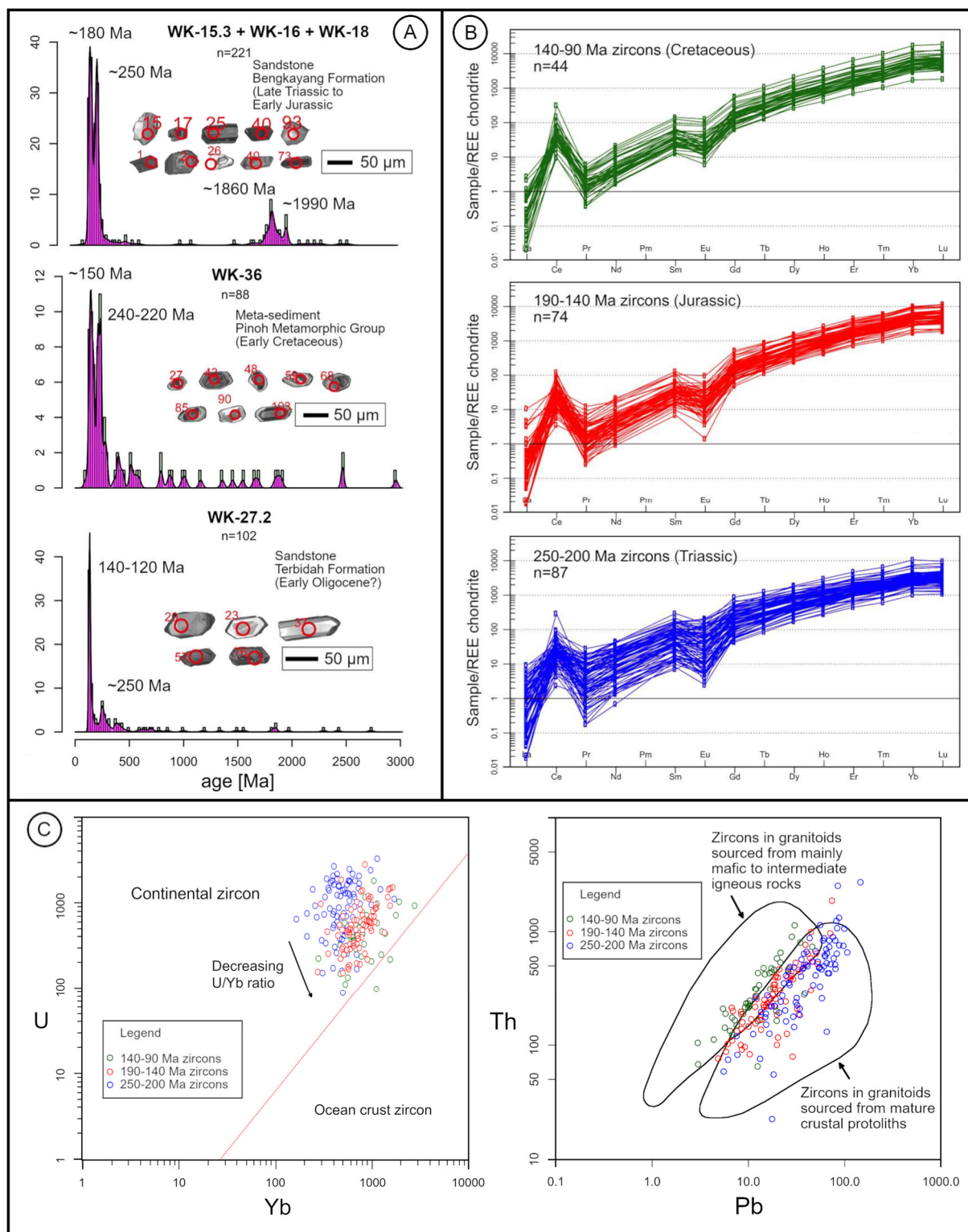


Fig. S1

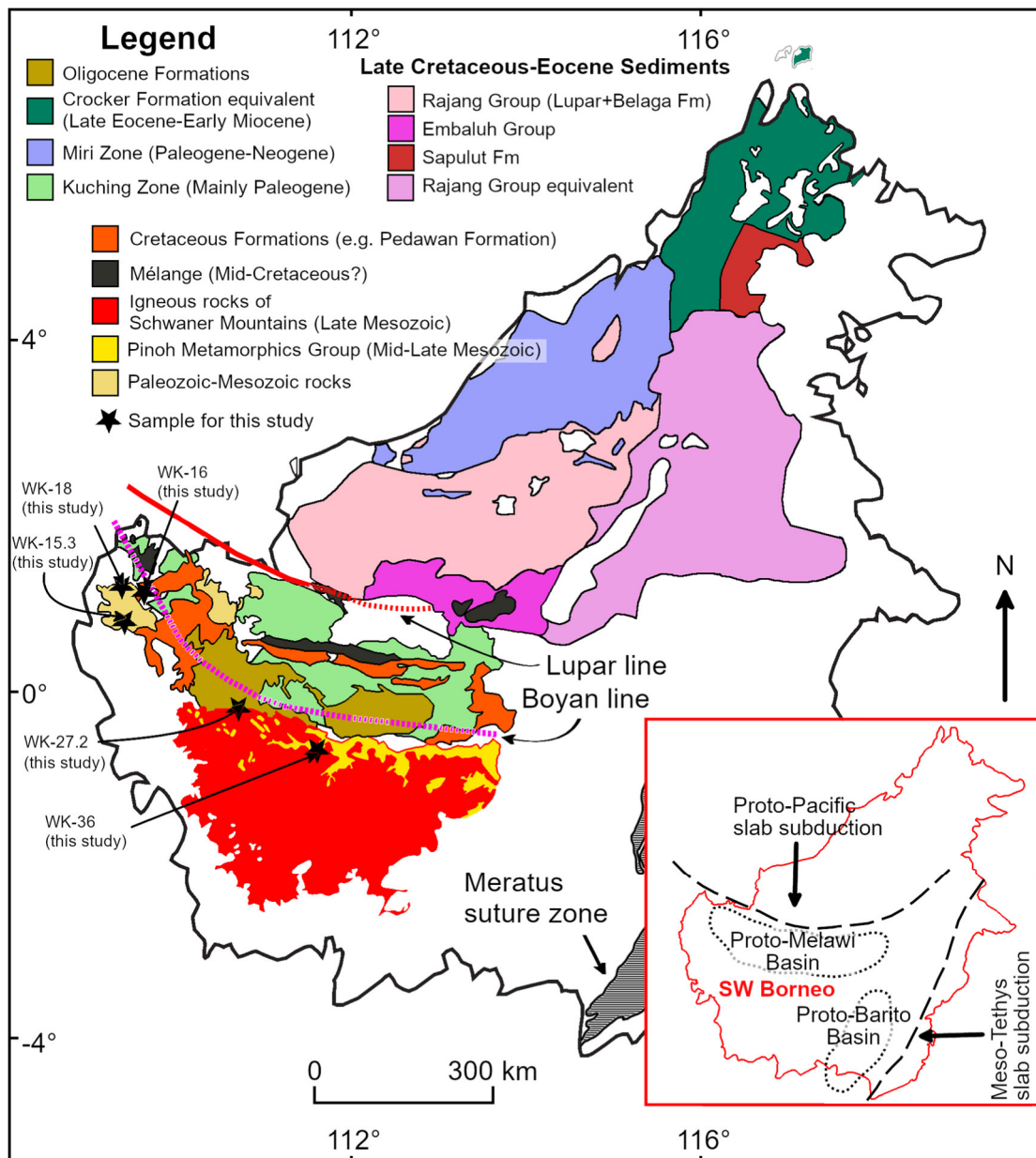


Fig. S2