Article

Finding of Ca. 1.6 Ga Detrital Zircons from the Mesoproterozoic Dagushi Group, Northern Margin of the Yangtze Block

Xiaofeng Xie ^{1,2}, Zhenning Yang ^{1,3,4,*}, Huan Zhang ^{1,5}, Ali Polat ^{6,7}, Yang Xu ¹ and Xin Deng ¹

¹ School of Earth Sciences, China University of Geosciences Wuhan, Wuhan 430074, China; jiansheng2865@126.com (X.X.); huanxiaozhangde@163.com (H.Z.); xuyang_0112@163.com (Y.X.); cugxd@163.com (X.D.)

² Geological Party 103, Guizhou Bureau of Geology & Mineral Exploration and Development, Tongren 554300, China

³ Hebei Key Laboratory of Strategic Critical Mineral Resources, Hebei GEO University, Shijiazhuang 050031, China

⁴ College of Earth Sciences, Hebei GEO University, Shijiazhuang 050031, China

⁵ The Second Geo-Exploration Institute of Mineral Prospecting and Development Bureau of Henan Province, Zhengzhou 450000, China

⁶ School of the Environment, University of Windsor, Windsor, ON N9B 3P4, Canada; polat@uwindsor.ca

⁷ Center for Global Tectonics, Faculty of Earth Sciences, China University of Geosciences Wuhan, Wuhan 430074, China

* Correspondence: znyang@hgu.edu.cn; Tel.: +86-311-8720-8285

Abstract: The middle Mesoproterozoic is a crucial time period for understanding the Precambrian tectonic evolutionary history of the northern Yangtze Block and its relationship with the supercontinent Columbia. The Dagushi Group (Gp) is one of the Mesoproterozoic strata rarely found at the northern margin of the Yangtze Block. U–Pb geochronology and Lu–Hf isotopic analyses of detrital zircons were analyzed for three metamorphic quartz sandstone samples collected from the Luohanling and Dangpuling formations of the Dagushi Gp. These metasandstones yielded major zircon populations at ~2.65 Ga and ~1.60 Ga, respectively. The ~1.60 Ga ages first discovered yield a narrow range of $\epsilon\text{Hf}(t)$ values from -1.8 to $+1.8$, which lie above the old crust evolutionary line of the Yangtze Block, suggesting the addition of mantle material. Trace element data indicate that ~1.60 Ga detrital zircons share a basic provenance, whereby they have low Hf/Th and high Nb/Yb ratios. Zircon discrimination diagrams suggest that the ~1.60 Ga detrital zircon source rocks formed in an intra-plate rifting environment. Dagushi Gp provenance studies indicate that the ~1.60 Ga detrital zircon was most likely sourced from the interior Yangtze Block. Thus, we suggest that the late Paleoproterozoic to early Mesoproterozoic continental break-up occurred at the northern margin of the Yangtze Block.

Keywords: 1.60 Ga; detrital zircon; Dagushi Group; Yangtze Block; Columbia supercontinent

Citation: Xie, X.; Yang, Z.; Zhang, H.; Polat, A.; Xu, Y.; Deng, X. Finding of Ca. 1.6 Ga Detrital Zircons from the Mesoproterozoic Dagushi Group, Northern Margin of the Yangtze Block. *Minerals* **2021**, *11*, 371. <https://doi.org/10.3390/min11040371>

Academic Editor:
Rubén Díez-Fernández

Received: 5 February 2021

Accepted: 29 March 2021

Published: 31 March 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

When compared with the supercontinents Pangea and Rodinia, the architecture of the supercontinent Columbia is ambiguous due to the lack of sufficient and reliable geological and paleomagnetic data [1–5]. There is a broad agreement that the fragmentation of Columbia commenced at ca. 1.60 Ga and formed a number of continental rift zones along the western margin of Laurentia [6,7], as marked by widespread ~1.60–1.20 Ga continental rifting, anorogenic magmatism, and emplacement of mafic dyke swarms in almost all cratonic building blocks [1,4,8]. The scarcity of ~1.60–1.50 Ga zircon sources worldwide [9] makes detrital zircons within this age range particularly useful for constraining the tectonic affinity between different continents.

Many ~1.75–1.50 Ga magmatic events in the southwestern Yangtze Block margin were reported in recent studies [8,10–12], and the contemporaneous rift strata were formed, including the Dongchuan, Hekou, and Dahongshan groups [13–16], which were interpreted to be linked to the break-up of the Columbia supercontinent. However, this geological event

has been rarely identified at the northern margin of the Yangtze Block. Previous studies have shown that the Shennongjia and Dagushi groups have undergone similar crustal evolution, and they are coeval successions deposited in similar environments [17–20]. Detrital zircon U–Pb ages and Lu–Hf isotopic compositions of the Shennongjia Gp were analyzed recently [18,21–23]. Xiao [18] first identified ~1.6 Ga detrital zircon from the Shennongjia Gp and contended that this time period corresponded to the breakup of the Yangtze Block from the Columbia supercontinent.

In this study, we report a new set of zircon U–Pb ages and Hf isotopic data for three meta-quartz sandstones from the Dagushi Gp. Combined with previous studies, our results shed new light on the regional tectonic evolution of the northern part of the Yangtze Block during the Late Paleo- to Mesoproterozoic, and they constrain a possible kinship between the Yangtze Block and the Columbia supercontinent.

2. Geological Setting

The Yangtze Block is sutured with the North China Craton along the Qinling–Dabie–Sulu orogenic belt to the north in the Triassic, which collided with the Cathaysia Block to the southeast in the early Neoproterozoic along the Sibao (or Jiangnan) orogeny (Figure 1a; [24]). The Kongling terrane is located at the northwestern part of the Yangtze Block (Figure 1a), which is exposed as a small dome of 360 km² and was intruded by the Paleoproterozoic Quanzitan granite and the huge Neoproterozoic Huangling complex (see [25] and references therein). There are three types of rock associations in this terrane: (1) dioritic, tonalitic, trondhjemitic, and granitic gneisses of intrusive origin (ca. 2.86–2.95 Ga), (2) metasedimentary rocks, and (3) amphibolite and locally preserved mafic granulite (see [25] and references therein). The study area is located in the Dahongshan region in the northern margin of the Yangtze Block, ~200 km east of the Kongling terrane (Figure 1a,b). It is separated from the Tongbai orogen to the north by the Sanligang–Sanyang Fault (Figure 1b) that is part of the east-trending Xiangfan–Guangji Fault.

The Dagushi Gp is the oldest basement exposed in the study area, unconformably overlain by the Huashan Gp, which is in turn overlain by the Nanhua sedimentary units including the Liantuo and Nantuo formations (Figure 1b). Lithologically, the Huashan Gp is divided into the Hongshansi Formation (Fm) at the bottom and the Liufangzui Fm at the top (Figure 1c) [26]. Recently, Du et al. [27] reported a zircon U–Pb age of $\sim 779 \pm 12$ Ma for a tuff layer from the Liantuo Fm. The five youngest zircons from the coarse-grained feldspathic sandstone in the Liufangzui Fm give a weighted average age of $\sim 816 \pm 9$ Ma [26], suggesting that initial deposition of the Huashan Gp occurred after ca. 816 Ma.

The sedimentary sequences of the Dagushi Gp include, from the bottom up, the Taiyangsi, Hanjiawa, Luohanling, Chenjiachong, Lijiazui, and Dangpuling formations [29]. The Taiyangsi Fm consists of metaconglomerate, meta-pebbly sandstone, medium-coarse- to fine-grained metasandstone intercalated with banded slate in the lower part, and meta-siltstone and clay slate in the upper section with visible lenticular bedding of sand and gravel [29], pointing to a subaqueous alluvial fan depositional system. Sedimentary characteristics suggest that the water depth increased gradually from the lower to the upper part of the Taiyangsi Fm. The lithological combinations of the Hanjiawa Fm, similar to the Taiyangsi Fm, are mainly slate with a subordinate amount of metasandstone and metaconglomerate. The Luohanling Fm, the most widespread strata of the Dagushi Gp, is composed of siliceous dolomite (Figure 2a), silicolites (Figure 2b), meta-quartz sandstone (Figure 2c), silty-muddy slate (Figure 2d), dolomite (Figure 2e), and various stromatolites. Subhorizontal beddings in this formation are formed in a tidal flat, shallow sea shelf environment. The Chenjiachong Fm contains micro- to fine-crystalline dolomite and stromatolitic dolomite with horizontal bedding. The Lijiazui Fm has silty-muddy slate with limestone lenses. The Dangpuling Fm consists of meta-quartz and meta-feldspar quartz sandstone (Figure 2f,g), with horizontal bedding and cross bedding, which is interpreted to have formed on a littoral shallow-water setting [29].

Figure 1. (a) Distribution of Precambrian rocks in the South China Block and the Qinling–Dabie Belt (modified after [24]); (b) simplified geological map of the Dahongshan area (modified after [28]); (c) 1:50,000 geological map of Guchengfan (modified after [29]; ages of the Luohanling Fm and the Liufangzui Fm are from [19,26], respectively); the red stars show the stratigraphic locations of the three metasandstone samples.

Tuff layers from the Luohanling Fm give two zircon U–Pb ages of ~1.23 Ga and ~1.24 Ga [19]. The two youngest zircons from the Taiyangsi Fm yield concordant dates of ~919 ± 10 Ma and ~912 ± 11 Ma (unpublished data). The youngest zircon date of ~1.12 Ga for the Taiyangsi Fm was provided by [30]. Thus, the depositional ages of the Taiyangsi Fm and the Hanjiawa Fm are constrained to the Neoproterozoic or the latest Mesoproterozoic.

The two medium-coarse-grained meta-quartz sandstone samples (JS14-1 and JS14-2) (Figure 2c), collected from the middle part of Luohanling Fm, are dominated by >95% quartz (Figure 2h). The coarse-grained meta-quartz sandstone sample (JS26), collected from the lower part of Dangpuling Fm (Figure 2f), is composed of 95% quartz and <3% lithic clasts (Figure 2i).

Figure 2. Field photographs (a–g) and photomicrographs (h,i) of the Dagushi Gp. (a) Siliceous dolomite; (b) siliceous-calcite; (c) meta-quartz sandstone; (d) silty-muddy slate; (e) dolomite; (f) meta-quartz sandstone; (g) meta-quartz sandstone; (h) sample JS14-1; and (i) sample JS26; Q: quartz.

3. Analytical Methods

3.1. Zircon U–Pb Dating

Zircons were separated by conventional magnetic and heavy liquid methods and then were selected, according to sizes, colors, shapes, and turbidity under a binocular microscope. The grains were then mounted on double-sided tape, cast in epoxy resin, and polished to expose even and intermediate surfaces. Zircon U–Pb dating was conducted by LA-ICP-MS at the State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences Wuhan (SKLGPMR-CUG). Laser sampling was performed using a GeoLas 2005 excimer ArF laser-ablation system. An Agilent 7500a ICP-MS instrument was used to acquire ion signal intensities. Standard zircon 91,500 [31] (Table A1, Appendix A) was employed as an external reference material to calibrate isotope fractionation, which was analyzed twice for every five analyses. Standard zircons GJ-1 were analyzed as unknowns [32] (Table A1, Appendix A). Detailed operating conditions for the laser ablation system and the ICP-MS instrument and data processing are the same as described by [33]. The data were analyzed in the ISOPLOT program of Ludwig [34]. Due to lower intensity of the ^{207}Pb signal, $^{206}\text{Pb}/^{238}\text{U}$ ages are usually more precise than $^{207}\text{Pb}/^{235}\text{U}$ and $^{207}\text{Pb}/^{206}\text{Pb}$ ages especially for zircons younger than 1.0 Ga [35]. However, $^{207}\text{Pb}/^{206}\text{Pb}$ ages are less sensitive to Pb loss, which is more common in older zircons [36]. Therefore, in most cases, $^{207}\text{Pb}/^{206}\text{Pb}$ ages are employed for zircons of age ≥ 1.0 Ga and $^{206}\text{Pb}/^{238}\text{U}$ ages are employed for zircons of age < 1.0 Ga.

3.2. Zircon Trace Element Analysis

The trace element analysis was performed simultaneously with the U–Pb analysis. Quantitative results for trace elements reported here were obtained through calibration of relative element sensitivities using the NIST-610 standard glass as the external calibration standard [37]. The precision and accuracy of the NIST-610 analyses is presented in Table A2

(Appendix A). Nb concentrations of 91,500 obtained in this study fall within the published variation ranges [38].

3.3. Zircon Lu–Hf Isotope Analysis

In situ Hf isotope analysis was carried out on a Neptune Plus MC-ICP-MS (Thermo Fisher Scientific, Germany), in combination with the GeoLas 2005 in the SKLGPMR-CUG. Detailed operating conditions for the laser ablation system and the MC-ICP-MS instrument and data calibrating and processing were reported in [39]. We applied the directly obtained β_{Yb} value from the zircon sample itself in real time [40]. The $^{179}\text{Hf}/^{177}\text{Hf}$ and $^{173}\text{Yb}/^{171}\text{Yb}$ ratios were used to calculate the mass bias of Hf (β_{Hf}) and Yb (β_{Yb}), which were normalized to $^{179}\text{Hf}/^{177}\text{Hf} = 0.7325$ [41] and $^{173}\text{Yb}/^{171}\text{Yb} = 1.132685$ [42] using an exponential correction for mass bias. Interference of ^{176}Yb on ^{176}Hf was corrected by measuring the interference-free ^{173}Yb isotope and using $^{176}\text{Yb}/^{173}\text{Yb} = 0.79639$ to calculate $^{176}\text{Yb}/^{177}\text{Hf}$ [43]. Similarly, the relatively minor interference of ^{176}Lu on ^{176}Hf was corrected by measuring the intensity of the interference-free ^{175}Lu isotope and using the recommended $^{176}\text{Lu}/^{175}\text{Lu} = 0.02656$ [44] to calculate $^{176}\text{Lu}/^{177}\text{Hf}$. Time-drift correction was performed using standard zircon 91,500. The interference and mass fractionation-corrected $^{176}\text{Hf}/^{177}\text{Hf}$ ratios of the samples were then calibrated against the standard using the recommended $^{176}\text{Hf}/^{177}\text{Hf}$ ratio of 0.282308 ± 6 (2σ) [45] (Table A3, Appendix A). Offline selection and integration of analytic signals, as well as mass bias calibrations, were performed using ICPMSDataCal [40]. To calculate the initial $^{176}\text{Hf}/^{177}\text{Hf}$ ratios, the decay constant of $1.867 \times 10^{-5} \text{ Ma}^{-1}$ was used for ^{176}Lu [46]. The $\varepsilon_{\text{Hf}(t)}$ values were calculated with reference to a chondritic uniform reservoir (CHUR). The $^{176}\text{Lu}/^{177}\text{Hf}$ and $^{176}\text{Hf}/^{177}\text{Hf}$ ratios used for the CHUR were 0.0332 and 0.282772, respectively [44]. The single-stage model age (T_{DM1}) was calculated relative to a depleted mantle with present-day $^{176}\text{Lu}/^{177}\text{Hf}$ and $^{176}\text{Hf}/^{177}\text{Hf}$ ratios of 0.0384 and 0.28325, respectively [47]. The two-stage Hf model age (T_{DM2}), also interpreted as crust formation age, was calculated by projecting the zircon $^{176}\text{Hf}/^{177}\text{Hf}(t)$ back to the depleted-mantle model growth curve, assuming a mean crustal value for Lu/Hf ($^{176}\text{Lu}/^{177}\text{Hf} = 0.015$) [48].

4. Results

4.1. Zircon Ages and Hf Isotopes

4.1.1. Dangpuling Fm

Sixty zircons were separated from sample JS26 of the Dangpuling Fm (Table A4, Appendix A) and were colorless, transparent, and mostly anhedral, suggesting a long-distance transport. They were 80–150 μm long with length/width ratios of 1.2:1 to 3:1. The majority of zircons showed clear oscillatory or broad zoning (Figure 3). Concentrations of U and Th were 50–843 ppm and 11–364 ppm, respectively. Th/U ratios ranged from 0.2 to 1.5. A major zircon population occurred in the range of ~2.59–2.69 Ga defining a strong peak at ca. 2.65 Ga with two small age populations of ~1.90 Ga and ~2.80 Ga (Figure 4). The oldest detrital zircon was dated at ~3.00 Ga.

4.1.2. Luohanling Fm

JS14-1: Seventy-three zircon grains were separated from sample JS14-1 of the Luohanling Fm and were analyzed for U–Pb ages (Table A4, Appendix A). Thirty-three representative dated zircons were selected for the Hf isotope analysis (Table A5, Appendix A). Zircons were colorless, khaki, and anhedral to subhedral. They were 100–200 μm long with length/width ratios of 1.1:1 to 2.5:1. Most zircons showed oscillatory zoning (Figure 3). Concentrations of U and Th were 155–1436 ppm and 78–2674 ppm, respectively. Th/U ratios ranged from 0.2 to 2.2. The significant U–Pb age population was at ~1.45–1.68 Ga with two small age populations of ~1.85–2.23 Ga and ~2.62–2.86 Ga, and the dominant peak appeared at ca. 1.60 Ga (Figure 4).

Figure 3. Cathodoluminescence images of zircon grains from three metasandstone samples JS26, JS14-1, and JS14-2. The smaller yellow circles denote the LA-ICP-MS dating spots, whereas the larger white circles the locations of Lu-Hf isotope analysis. Zircon U-Pb ages and $\epsilon\text{Hf}(t)$ values together with 1σ uncertainties are shown for individual spots.

Figure 4. U-Pb concordia plots of detrital zircons (left panel) and corresponding relative probability density diagrams of zircon ages (right panel) from the Dagushi Gp.

Zircon grains for ca. 1.60 Ga had chiefly positive $\epsilon\text{Hf}_{(t)}$ values and showed a range from -1.8 to $+1.8$ (Table A5, Appendix A). Paleoproterozoic zircons (ca. 2.65 Ga) mostly had $\epsilon\text{Hf}_{(t)}$ values ranging from -1.1 to $+1.4$. Three older zircons (ca. 2.85 Ga) showed variable $\epsilon\text{Hf}_{(t)}$ values from -0.8 to $+0.1$.

JS14-2: Thirty zircon grains were separated from sample JS14-2 from the Luohanling Fm and were analyzed for U–Pb ages (Table A4, Appendix A). The morphological features of detrital zircons were similar to those of sample JS14-1. The major age population was ~ 1.55 – 1.68 Ga with two small age populations of ~ 1.78 – 2.32 Ga and ~ 2.62 – 2.79 Ga, and the major peak was at ca. 1.60 Ga (Figure 4).

5. Discussion

5.1. Provenance of the Dagushi Gp

The detrital zircon ages from the Dagushi Gp in our study yielded two major peaks at ~ 2.65 Ga and ~ 1.60 Ga (Figures 4 and 5a). The Luohanling Fm had two age peaks (~ 1.60 Ga and ~ 2.65 Ga), while the Dangpuling Fm had only one (~ 2.65 Ga), demonstrating significant discrepancy in the age spectrum among different samples. In addition, Kong et al. [49] reported ages from the Lijiazui and Luohanling formations, which are distinctly different from U–Pb ages presented above, reflecting changes in provenance for individual Dagushi Gp samples.

The ~ 2.65 Ga magmatism is widespread in the northern margin of the Yangtze Block, such as ~ 2.70 – 2.60 Ga A-type granitic gneisses [50], ~ 2.66 Ga biotite granites, and ~ 2.70 – 2.64 Ga two-mica granites [51] in the Kongling terrane with ~ 2.65 Ga A-type granites [52,53] in the Huji area, northern Hubei Province. The oldest rocks exposed in the Kongling terrane are tonalite–trondhjemite–granodiorite (TTG) gneisses that formed in two time intervals: ~ 3.40 – 3.20 Ga and ~ 2.90 – 2.80 Ga [54–58], which may offer materials for ~ 2.80 – 3.00 Ga detrital zircons.

A number of ~ 2.20 – 1.80 Ga metamorphic and magmatic events have been identified in the Kongling terrane and its surrounding areas in the northern part of the Yangtze Block [25,59–64]. Two major phases of juvenile crustal growth, ~ 2.20 – 2.10 Ga in the Kongling terrane and the Tongbai–Dabie orogeny [65,66] and ~ 1.85 Ga in the Dabie–Sulu orogeny [65], were also documented. Yang et al. [26] reported abundant ~ 2.00 Ga detrital zircon around the Yangtze Block. Thus, we prefer an interpretation that the ~ 1.80 – 2.30 Ga detrital zircons in the Dagushi Gp were predominantly derived from the interior of the Yangtze Block.

Magmatism and metamorphism at ca. 1.60 Ga have not been documented in the northern margin of the Yangtze Block except for the detrital zircon ages obtained from the Shennongjia Gp (Figure 5c) [18]. This episode of magmatism and contemporaneous detrital zircon U–Pb ages have been confirmed in the southwestern [11,14,67–69] and southeastern margins of the Yangtze Block (Figure 5b,d). Thus, the major contributor to these ~ 1.60 Ga detrital zircons may lie in the Yangtze Block itself rather than an external continent. At ca. 1.60 Ga the Qinling Belt was part of the South China Craton, and the proto-Yangtze Block may have been located in the position at the nexus of north Laurentia, southwest Siberia, and north Austria [70]. Thus, they could also have served as sources for ~ 1.60 Ga detrital zircons. Li et al. [19] proposed that the Dagushi Gp correlates well with the Shennongjia Gp in terms of sedimentology and geochronology. The newly acquired ~ 1.60 Ga detrital zircon ages and corresponding $\epsilon\text{Hf}_{(t)}$ values reported in this study (Figure 6a) further corroborate this correlation. Both groups are interpreted to have formed in a continental rift setting [17], as suggested by the occurrence of intra-plate alkali and tholeiitic basalts in the Shennongjia Gp [71]. Wang et al. [72] suggested that the Shennongjia Gp was deposited during a transgressive system tract in a carbonate ramp steepening toward the west. The clastic rocks are widely distributed in the Shennongjia strata, suggesting continued terrestrial material input mainly from the ancient Yangtze land to the south. These lines of evidence suggest that the ~ 1.60 Ga detrital zircons of the Dagushi Gp may have also been derived

from the interior of the Yangtze Block. In addition, the narrow age spectrum and ϵHf_t values of these zircons favor a single source.

Figure 5. Age probability diagrams of detrital zircons from Precambrian metasedimentary rocks in the South China Block [18,21,68,73–80]. (a) age probability diagrams of detrital zircons from the Dagushi Gp; (b) age probability diagrams of detrital zircons from the Kunyang Gp; (c) age probability diagrams of detrital zircons from the Shennongjia Gp; (d) age probability diagrams of detrital zircons from the Sibao Gp and Danzhou Gp.

Figure 6. (a) A comparison of ϵHf_t values of 1800–1350 Ma zircons from the Mesoproterozoic strata in the northern and western margins of the Yangtze Block [18,70,81]; (b) plots of ϵHf_t values versus crystallization ages for detrital zircons from the eastern Yangtze Block (data are from Yang et al. [26] and references therein, as well as this study).

5.2. Tectonic Setting for Sedimentation of the Dagushi Gp

Indications of magmatic events between ~1.75 Ga and ~1.50 Ga are commonly recorded at the southwestern margin of the Yangtze Block. The rock assemblages are dominated by alkaline–subalkaline metamorphosed mafic volcanic rock and gabbro–diabase

dikes constituting a bimodal distribution together with minor A-type granites [82]. Most rocks have high Ti and rare earth and trace element patterns similar to those of continental flood basalts (CFB) and ocean island basalts (OIB) [8,10–12], while some show enriched mid-ocean ridge basalt (E-MORB) or transitional features between E-MORB and OIB [83–85]. All fall into within-plate basalt fields on the Zr/Y–Zr, Ti/100–Zr–Y $\times$ 3, Hf/3–Th–Ta, and Nb $\times$ 2–Zr/4–Y diagrams [83–85].

The $\epsilon\text{Hf}(t)$ values of ~ 1.80 – 1.35 Ga zircons in the northern and western margin of the Yangtze Block overlap (Figure 6a), indicating the similarity of their sources. The $\epsilon\text{Hf}(t)$ values are significantly elevated at ~ 1.60 – 1.40 Ga, as illustrated by the evolution curve of ancient rocks in the interior of the Yangtze Block (Figure 6b). Additionally, Xiao [18] reported zircon $\delta^{18}\text{O}$ values between +5.41 and +5.67, suggesting that mantle-derived materials were added to the crust during this period. Trace element compositions of zircon are useful for delineating its source rock types [86], and those of ~ 1.60 Ga detrital zircons from the Dagushi Gp are shown in Figure 7 and in Table A6 (Appendix A). According to the classification and regression tree (CART-tree) model (Figure 7a, [86]), the source rocks of detrital zircons from the Dagushi Gp are mainly basic (Figure 7b).

Figure 7. (a) Classification and regression tree (CART-tree) for classification of zircons by rock types [86]; (b) source rock types of ~ 1.60 Ga zircons from the Dagushi Gp.

Broadly speaking, trace element characteristics of magmatic zircon could also reflect the compositions of its source magma and the crystalline environment [86,87]. The ca. 1.60 Ga detrital zircons from the Dagushi Gp have a median Nb concentration of 17 ppm, significantly higher than that of continental arcs (1.7 ppm) and MOR (1.6 ppm) [88]. In addition, they have U/Yb ratios (mostly 0.1–1.3) intermediate between those of MOR and typical continental crustal zircons, but higher than Icelandic basalt [89]. On the Hf/Th–Th/Nb and Nb/Hf $\times$ 10,000–Th/U discrimination diagrams (Figure 8a,b), zircons from the Dagushi Gp mostly fall in the field of within-plate/anorogenic environments. On the U/Yb–Hf and U/Yb–Nb/Yb $\times$ 10,000 discrimination diagrams (Figure 8c,d), they mostly plot in the Hawaii–Iceland field. A subset of zircons with high U/Yb and Hf/Th ratios fall outside the within-plate area (Figure 8a,d), which can be attributed to the fractional crystallization of minerals such as titanite, ilmenite, and zircon. These minerals exert a dominant control on the U, Yb, Nb, and Hf elements of the remaining melt, and they enrich U and Hf in later-formed grains [88]. We interpret the source rocks to have been formed in an intra-plate rifting environment, according to the Hf and O isotope and zircon trace element compositions.

Xiong and Chen [17] argued that the Shennongjia Gp and Dagushi Gp were deposited in the Mesoproterozoic aulacogen at the northern margin of the Yangtze Block. Li et al. [21] believed that the upper subgroup of the Shennongjia Gp and the Dagushi Gp represented a shallow marine environment at the margin of the initial rift basin. Liu et al. [71] reported a set of metabasalt (alkaline basalt series)–tuff (tholeiite basalt series) assemblages from the Shicaohe Fm of the Shennongjia Gp, and they attributed their geochemical characteristics to within-plate rift basalts. These lines of evidence may indicate a long-term rifting history in the northern margin of the Yangtze Block during the Mesoproterozoic.

Figure 8. (a) Plot of Hf/Th vs. Th/Nb; (b) plot of Nb/Hf $\times$ 10,000 vs. Th/U; (c) plot of U/Yb vs. Hf; (d) plot of U/Yb vs. Nb/Yb $\times$ 10,000 [88,90–92].

5.3. Reconstruction of the Supercontinent Columbia

Active continental margin magmatism occurred along the margin of the supercontinent Columbia at ca. 1.80–1.40 Ga, with rift-type magmatic pulses in its interior [93]. Detrital zircons dated at ca. 1.70–1.50 Ga are documented from the western, southwestern, and northern margins of the Yangtze Block, as well as in minor amounts from the southeastern margin of the Yangtze Block; in contrast, these Paleo- to Mesoproterozoic detrital zircons are rare in the interior of the Yangtze Block [20]. As discussed above, ca. 1.60 Ga detrital zircons of the Dagushi Gp and Shennongjia Gp have nearly chondritic Hf isotope composition, mantle-source oxygen isotope composition, and primitive properties of basalts, which are trace element characteristics of intra-plate magma, indicating a derivation from typical intra-plate magmatic events. Thus, we suggest that extensive break-up may have occurred at the periphery of the Yangtze Block, responding to the fragmentation of the supercontinent Columbia. Meanwhile, widespread ~1.60–1.30 Ga Mesoproterozoic post-orogenic and anorogenic magmatism has been identified in many Precambrian cratons, including the ~1.60 Ga Dalma magmatic rocks in northeast India [94], the ~1.59 Ga tholeiitic dyke swarms in South America [95], the ~1.50 Ga mafic dykes in South America [96], and the ca. 1.50 Ga mafic magmatism in South China [8]. The marked contrast with arc magmatism at the margin of the supercontinent Columbia [97–99] further suggests that the Yangtze Block may have been located at the center of the supercontinent Columbia (Figure 9).

Figure 9. The position of the Yangtze Block in the reconstruction of the supercontinent Columbia (modified after [7,100]).

6. Conclusions

- (1) The detrital zircon spectra of the Dagushi Gp shows two distinct age peaks of ~2.65 Ga and ~1.60 Ga, which are compatible with the magmatism reported from the Yangtze Block. Sedimentological and geochronological comparisons between the Dagushi and the Shennongjia groups indicate that the groups were probably coeval units. Provenance studies suggest the sediments of the Dagushi Gp could be derived from mafic source regions within the Yangtze Block.
- (2) The ~1.60 Ga ages first discovered yield a narrow range of ϵHf_t values from -1.8 to $+1.8$, which lie above the old crust evolutionary line of the Yangtze Block, suggesting the addition of mantle material.
- (3) Most ~1.60 Ga detrital zircons are plotted into the within-plate/anorogenic field. The Yangtze Block was likely a fragment of the Paleo- to Mesoproterozoic supercontinent Columbia and may have been located in its center rather than its margin.

Author Contributions: Conceptualization, X.X. and Z.Y.; methodology, X.X.; software, H.Z.; validation, X.X. and Z.Y.; investigation, Y.X. and X.D.; data curation, H.Z.; writing—original draft preparation, X.X. and H.Z.; writing—review and editing, Z.Y. and A.P.; supervision, Z.Y.; funding acquisition, Z.Y. All authors have read and agreed to the published version of the manuscript.

Funding: This study was supported by the Natural Science Foundation of Hebei Province (Grant No. D2020403095), the National Natural Science Foundation of China (Grant Nos. 41172189 and 41472190), and the China Geological Survey Bureau (Grant No. DD20190050).

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to the research process of this project.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. LA-ICP-MS U–Pb isotopic data of standard zircons.

Analysis	Sample	Pb	Th	U	Isotopic Ratios						Age (Ma)						Concordia
No.	Name	(ppm)	(ppm)	(ppm)	²⁰⁷ Pb/ ²⁰⁶ Pb	1σ	²⁰⁷ Pb/ ²³⁵ Pb	1σ	²⁰⁶ Pb/ ²³⁸ Pb	1σ	²⁰⁷ Pb/ ²⁰⁶ Pb	1σ	²⁰⁷ Pb/ ²³⁵ Pb	1σ	²⁰⁶ Pb/ ²³⁸ Pb	1σ	
Standard Zircon 91500 as an External Standard (Reference ²⁰⁶ Pb/ ²³⁸ U Age = 1062.4 ± 0.8 Ma, 2σ [31])																	
<i>JS14-1</i>																	
SEP16A02	91500std	83	80	230	0.0748	0.0022	1.8589	0.0540	0.1805	0.0026	1065	56	1067	19	1070	14	99%
SEP16A03	91500std	83	82	233	0.0749	0.0022	1.8415	0.0543	0.1778	0.0026	1133	59	1060	19	1055	14	99%
SEP16A07	91500std	83	83	235	0.0749	0.0019	1.8502	0.0464	0.1792	0.0024	1065	51	1064	17	1062	13	99%
SEP16A15	91500std	85	82	235	0.0744	0.0022	1.8281	0.0524	0.1785	0.0026	1051	59	1056	19	1059	14	99%
SEP16A16	91500std	83	81	231	0.0754	0.0023	1.8723	0.0558	0.1798	0.0026	1080	61	1071	20	1066	14	99%
SEP16A23	91500std	84	81	235	0.0749	0.0021	1.8502	0.0517	0.1792	0.0024	1065	56	1064	18	1062	13	99%
SEP16A31	91500std	83	80	230	0.0752	0.0025	1.8576	0.0639	0.1788	0.0026	1074	67	1066	23	1060	14	99%
SEP16A32	91500std	82	81	233	0.0746	0.0025	1.8428	0.0601	0.1796	0.0026	1057	67	1061	21	1065	14	99%
SEP16A39	91500std	83	81	231	0.0773	0.0025	1.9048	0.0644	0.1784	0.0026	1129	66	1083	23	1058	14	97%
SEP16A40	91500std	93	91	258	0.0725	0.0023	1.7956	0.0571	0.1799	0.0026	998	64	1044	21	1066	14	97%
SEP16A48	91500std	86	82	234	0.0738	0.0023	1.8224	0.0595	0.1791	0.0027	1035	63	1054	21	1062	15	99%
SEP16A49	91500std	84	82	236	0.0760	0.0024	1.8780	0.0611	0.1792	0.0026	1094	68	1073	22	1063	14	99%
SEP16A56	91500std	84	82	233	0.0755	0.0024	1.8716	0.0583	0.1797	0.0028	1083	62	1071	21	1066	15	99%
SEP16A57	91500std	84	79	231	0.0742	0.0024	1.8288	0.0604	0.1786	0.0028	1048	71	1056	22	1059	15	99%
SEP16A64	91500std	83	81	233	0.0749	0.0021	1.8502	0.0504	0.1792	0.0024	1065	56	1064	18	1062	13	99%
SEP16A72	91500std	90	85	244	0.0767	0.0024	1.8961	0.0586	0.1791	0.0027	1122	62	1080	21	1062	15	98%
SEP16A73	91500std	85	82	238	0.0731	0.0023	1.8043	0.0568	0.1793	0.0027	1017	65	1047	21	1063	15	98%
SEP16A80	91500std	82	79	231	0.0731	0.0024	1.7981	0.0607	0.1785	0.0027	1017	68	1045	22	1059	15	98%
SEP16A81	91500std	88	86	242	0.0767	0.0024	1.9023	0.0600	0.1798	0.0026	1122	64	1082	21	1066	14	98%
SEP16A91	91500std	81	81	232	0.0741	0.0023	1.8402	0.0583	0.1797	0.0028	1056	63	1060	21	1066	16	99%
SEP16A92	91500std	86	81	236	0.0756	0.0024	1.8602	0.0583	0.1786	0.0028	1087	65	1067	21	1059	15	99%
Average N = 21		85	82	235	0.0749	0.0023	1.8502	0.0573	0.1792	0.0026	1070	62	1063	20	1062	14	
<i>JS14-2</i>																	
JUN22F02	91500std	31	31	84	0.074351	0.002171	1.819084	0.052852	0.177726	0.002108	1051	59	1052	19	1055	12	99%
JUN22F03	91500std	30	30	81	0.075409	0.002125	1.881316	0.055478	0.180614	0.002297	1080	61	1075	20	1070	13	99%
JUN22F14	91500std	30	29	81	0.075724	0.002173	1.859439	0.050115	0.178574	0.002645	1087	57	1067	18	1059	14	99%
JUN22F15	91500std	31	30	82	0.074036	0.002178	1.840961	0.052061	0.179766	0.002259	1043	59	1060	19	1066	12	99%
JUN22F22	91500std	29	30	82	0.073122	0.002133	1.796333	0.054674	0.177865	0.002199	1017	55	1044	20	1055	12	98%
JUN22F23	91500std	31	29	81	0.076638	0.002296	1.904067	0.059651	0.180475	0.002345	1122	61	1083	21	1070	13	98%
JUN22F30	91500std	31	30	83	0.076342	0.002141	1.900045	0.051711	0.181332	0.002255	1106	52	1081	18	1074	12	99%
JUN22F31	91500std	31	31	85	0.073418	0.001879	1.800355	0.048089	0.177008	0.001911	1026	52	1046	17	1051	10	99%
JUN22F38	91500std	31	30	83	0.074426	0.002088	1.845738	0.052396	0.179976	0.002436	1054	57	1062	19	1067	13	99%
JUN22F39	91500std	31	31	83	0.075334	0.002264	1.854662	0.056284	0.178364	0.002215	1077	60	1065	20	1058	12	99%
JUN22F46	91500std	30	30	82	0.073506	0.002322	1.823339	0.058917	0.179551	0.002457	1028	69	1054	21	1065	13	98%

Table A1. Cont.

Analysis	Sample	Pb	Th	U	Isotopic Ratios						Age (Ma)						Concordia
No.	Name	(ppm)	(ppm)	(ppm)	²⁰⁷ Pb/ ²⁰⁶ Pb	1σ	²⁰⁷ Pb/ ²³⁵ Pb	1σ	²⁰⁶ Pb/ ²³⁸ Pb	1σ	²⁰⁷ Pb/ ²⁰⁶ Pb	1σ	²⁰⁷ Pb/ ²³⁵ Pb	1σ	²⁰⁶ Pb/ ²³⁸ Pb	1σ	
JUN22F47	91500std	29	29	80	0.076254	0.002375	1.877061	0.056903	0.178789	0.002384	1102	62	1073	20	1060	13	98%
Average N = 12		30	30	82	0.0749	0.0022	1.8502	0.0541	0.1792	0.0023	1066	59	1063	19	1062	13	
Standard Zircon GJ-1 as an Unknown (Reference ²⁰⁶ Pb/ ²³⁸ U age = 599.8 ± 1.7 Ma, 2σ [32])																	
<i>JS14-1</i>																	
SEP16A04	GJ-1	77	27	911	0.0636	0.0016	0.8572	0.0215	0.0974	0.0013	728	56	629	12	599	8	95%
SEP16A05	GJ-1	75	26	910	0.0605	0.0013	0.8203	0.0190	0.0977	0.0012	620	81	608	11	601	7	98%
SEP16A06	GJ-1	75	26	918	0.0603	0.0012	0.8066	0.0167	0.0966	0.0012	617	43	601	9	594	7	98%
SEP16A88	GJ-1	75	26	913	0.0615	0.0015	0.8214	0.0207	0.0966	0.0014	655	47	609	12	595	8	97%
SEP16A89	GJ-1	75	26	920	0.0604	0.0015	0.8160	0.0202	0.0977	0.0014	620	54	606	11	601	8	99%
SEP16A90	GJ-1	75	26	920	0.0606	0.0015	0.8174	0.0209	0.0977	0.0014	633	54	607	12	601	8	99%
Average N = 6		75	26	916	0.0611	0.0014	0.8231	0.0198	0.0973	0.0013	646	56	610	11	598	8	98%
<i>JS14-2</i>																	
JUN22F04	GJ-1	26	9	301	0.059788	0.001456	0.835935	0.021002	0.101007	0.001023	594	56	617	12	620	6	99%
JUN22F05	GJ-1	26	9	306	0.060316	0.001449	0.827422	0.019914	0.099093	0.000941	617	52	612	11	609	6	99%
Average N = 2		26	9	0.0601	0.0015	0.8317	0.0205	0.1001	0.0010	0.0601	606	54	615	11	615	6	

Table A2. Trace element data of standard zircons.

Spot No.	Ti	Y	Nb	Ce	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
<i>JS14-1</i>																			
NIST-610	437	439	420	444	435	454	461	443	443	426	447	421	423	465	428	375	452	451.9	425.7
NIST-610	437	439	420	444	435	454	461	443	443	426	447	421	423	465	428	375	452	451.9	425.7
NIST-610	437	439	420	444	435	454	461	443	443	426	447	421	423	465	428	375	452	451.9	425.7
91500std	4.6	135	0.77	2.58	0.06	0.4	0.16	2.01	0.83	11.0	4.64	24.1	6.05	67.0	13.0	5780	0.5	28.9	77
91500std	3.5	141	0.75	2.62	0.27	0.4	0.24	2.24	0.92	11.6	4.91	24.8	6.44	69.6	13.4	5852	0.6	30.2	80
91500std	5.1	139	0.80	2.79	0.01	0.0	0.21	2.05	0.88	11.3	4.79	24.7	6.35	69.3	13.5	5750	0.5	30.0	79
91500std	3.0	136	0.77	2.75	0.23	0.3	0.25	1.97	0.83	11.4	4.66	23.2	6.11	67.3	13.3	5668	0.5	29.0	83
91500std	5.3	139	0.70	2.58	0.15	0.5	0.33	2.46	0.82	11.2	4.70	24.8	6.29	69.2	13.3	5756	0.6	29.3	78
91500std	4.0	137	0.73	2.69	0.03	0.4	0.31	2.17	0.86	11.1	4.88	24.7	6.13	68.1	13.1	5704	0.5	28.8	77
91500std	4.4	137	0.70	2.73	0.16	0.4	0.26	2.28	0.93	10.6	4.60	24.4	6.15	68.2	13.1	5702	0.6	28.8	77

Table A2. Cont.

Spot No.	Ti	Y	Nb	Ce	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
91500std	2.9	135	0.66	2.69	0.26	0.6	0.23	1.98	0.84	11.5	4.78	23.7	6.26	67.3	13.2	5749	0.5	29.3	78
91500std	3.5	136	0.64	2.84	0.24	0.3	0.26	2.21	0.91	11.3	4.55	24.2	6.29	67.7	13.2	5729	0.5	28.6	77
91500std	6.2	139	0.70	2.66	0.14	0.3	0.22	2.13	0.90	11.1	4.78	24.6	6.14	68.7	13.3	5715	0.5	29.3	79
91500std	4.9	138	0.70	2.43	0.23	0.5	0.21	2.33	0.89	11.9	4.93	25.5	6.34	69.1	13.5	5850	0.6	29.6	79
91500std	3.5	151	0.67	2.69	0.15	0.5	0.34	2.15	0.90	12.3	5.38	27.7	6.74	75.0	14.7	5888	0.6	33.5	89
91500std	4.1	142	0.70	2.73	0.33	0.5	0.23	2.14	0.98	11.4	4.75	25.6	6.50	70.5	13.7	5916	0.6	30.4	81
91500std	7.2	142	0.79	2.82	0.04	0.6	0.35	2.29	0.80	11.3	4.86	25.0	6.49	70.2	13.8	5879	0.5	30.6	82
91500std	4.8	144	0.70	2.94	0.13	0.5	0.26	2.44	0.91	11.8	5.01	25.7	6.66	71.5	13.8	5948	0.6	30.9	82
91500std	6.9	139	0.72	2.71	0.20	0.3	0.22	2.15	0.82	11.5	4.74	25.2	6.10	69.6	13.5	5831	0.6	29.8	80
91500std	5.7	140	0.72	2.64	0.38	0.6	0.22	1.82	0.90	11.5	4.77	24.7	6.22	70.4	13.7	5900	0.6	30.2	81
91500std	6.5	149	0.75	2.74	0.19	0.5	0.36	2.32	0.97	12.2	5.33	26.6	6.89	75.4	14.6	6309	0.6	31.8	85
91500std	5.8	150	0.65	2.98	0.11	0.5	0.27	2.94	0.93	12.3	5.17	26.3	6.68	73.6	14.4	6079	0.6	32.6	87
91500std	6.7	150	0.79	2.82	0.31	0.4	0.26	2.75	0.98	12.1	5.36	26.9	6.70	75.3	14.6	6248	0.6	31.9	86
91500std	5.4	144	0.71	2.88	0.18	0.6	0.31	2.52	0.90	12.0	5.02	26.1	6.72	72.9	14.4	6136	0.6	30.7	83
91500std	4.5	151	0.62	2.99	0.00	0.3	0.37	2.58	0.82	12.7	5.27	27.5	7.07	75.0	14.8	6154	0.6	33.2	87
91500std	2.2	146	0.71	2.75	0.27	0.6	0.27	2.40	0.93	12.1	4.99	26.2	6.72	72.9	14.4	6213	0.6	31.3	83
91500std	5.9	149	0.77	2.79	0.21	0.3	0.20	2.51	0.93	12.0	5.34	27.7	6.86	76.0	14.8	6325	0.6	32.2	86
GJ-1	2.78	249	1.56	16.9	0.73	1.38	0.95	7.1	2.07	20.6	7.20	29.6	6.56	66.8	12.8	6779	0.46	10.01	317
GJ-1	2.04	248	1.73	16.5	0.67	1.53	0.98	6.9	1.95	20.4	6.97	29.9	6.32	65.8	13.1	6702	0.49	9.68	312
GJ-1	3.37	251	1.62	16.8	0.58	1.77	0.95	7.1	2.07	20.3	7.04	30.5	6.56	66.4	13.2	6800	0.45	9.82	320
GJ-1	4.70	270	1.75	18.3	0.75	1.63	0.91	7.7	2.17	23.4	7.94	33.5	7.18	71.5	14.3	7466	0.49	10.63	348
GJ-1	5.49	263	1.69	17.8	0.65	1.45	1.13	7.3	2.15	21.4	7.61	32.2	7.07	71.5	14.2	7313	0.48	10.36	342
GJ-1	5.50	263	1.69	17.9	0.65	1.45	1.13	7.3	2.15	21.5	7.62	32.2	7.08	71.6	14.2	7323	0.48	10.38	343
<i>JS14-2</i>																			
NIST-610	433	421	419	447	431	450	461	441	442	418	444	410	416	434	425	372	451	433.1	430.0
91500std	5.0	153	0.82	2.94	0.28	0.5	0.24	2.84	1.05	12.6	5.47	28.8	7.39	77.0	14.6	5999	0.6	34.5	88
91500std	4.8	147	0.82	2.77	0.28	0.5	0.23	2.46	1.03	12.6	5.25	26.7	7.27	72.1	14.1	5820	0.5	32.9	84
91500std	4.7	145	0.77	2.59	0.28	0.5	0.20	2.56	0.97	12.9	5.14	26.7	6.91	73.7	14.1	5910	0.6	31.9	83
91500std	6.0	148	0.86	2.88	0.22	0.5	0.27	2.45	1.00	12.5	5.36	26.9	7.14	74.8	14.5	5995	0.6	33.0	84
91500std	6.0	147	0.75	2.63	0.30	0.6	0.26	2.85	1.00	12.6	5.15	27.2	7.17	73.4	14.3	5929	0.6	32.3	83
91500std	5.5	145	0.87	2.86	0.34	0.4	0.29	2.83	0.96	12.5	5.35	26.4	7.05	72.9	14.2	5952	0.6	32.0	84
91500std	5.7	152	0.86	2.65	0.30	0.6	0.31	2.35	1.00	13.1	5.56	27.8	7.46	76.8	14.7	6024	0.6	33.9	88
91500std	5.8	158	0.77	2.87	0.33	0.5	0.35	2.95	1.02	13.8	5.65	29.1	7.82	80.3	15.0	6203	0.6	34.9	91
91500std	6.4	158	0.86	3.10	0.47	0.6	0.33	2.89	1.11	13.3	5.65	28.5	7.84	77.8	14.9	6045	0.6	34.2	89
91500std	2.9	155	0.80	2.90	0.20	0.7	0.29	2.98	1.06	12.4	5.68	27.8	7.55	77.4	14.9	6063	0.6	35.2	89
91500std	4.7	154	0.79	2.67	0.29	0.6	0.31	2.62	0.96	13.3	5.46	28.2	7.49	75.7	14.7	6184	0.6	33.9	88
91500std	6.6	152	0.91	2.98	0.34	0.7	0.29	2.60	1.01	13.0	5.70	27.7	7.53	77.8	15.2	6412	0.6	33.2	87
GJ-1	3.78	219	1.53	14.7	0.40	1.51	1.01	6.7	1.86	18.8	6.26	27.8	6.44	60.6	11.4	6109	0.49	8.67	284
GJ-1	2.91	233	1.60	15.3	0.68	1.40	1.02	7.4	1.97	19.5	7.03	28.7	6.62	64.2	12.5	6579	0.46	9.22	304

Table A3. LA-ICP-MS Lu–Hf isotopic data of standard zircons.

Analysis	Sample	¹⁷⁶ Hf/ ¹⁷⁷ Hf		¹⁷⁶ Lu/ ¹⁷⁷ Hf		¹⁷⁶ Yb/ ¹⁷⁷ Hf		Hf	Yb	Lu	εHf(0)	1σ
No.	Name	Ratio	1σ	Ratio	1σ	Ratio	1σ	(ppm)	(ppm)	(ppm)		
Standard Zircon 91500 as an External Standard (Reference ¹⁷⁶ Hf/ ¹⁷⁷ Hf Value = 0.282308 ± 6, 2σ [45])												
JAN14A19	91500	0.282419	0.000034	0.000293	0.000001	0.006889	0.000022	6293	77	14	−12.5	1.3
JAN14A20	91500	0.282188	0.000027	0.000294	0.000001	0.006999	0.000039	6234	76	14	−20.6	1.1
JAN14A28	91500	0.282408	0.000018	0.000288	0.000001	0.006683	0.000022	8714	103	19	−12.9	0.8
JAN14A29	91500	0.282368	0.000023	0.000286	0.000001	0.006635	0.000034	8619	101	18	−14.3	1.0
JAN14A37	91500	0.282409	0.000031	0.000299	0.000001	0.007099	0.000030	5832	72	13	−12.8	1.2
JAN14A38	91500	0.282421	0.000042	0.000294	0.000001	0.006912	0.000035	6353	78	14	−12.4	1.6
JAN14A46	91500	0.282490	0.000042	0.000297	0.000001	0.006949	0.000039	6056	74	13	−10.0	1.6
JAN14A47	91500	0.282594	0.000030	0.000286	0.000001	0.006720	0.000041	5851	70	12	−6.3	1.2
JAN14A55	91500	0.282362	0.000033	0.000297	0.000001	0.006890	0.000028	6470	79	14	−14.5	1.3
JAN14A56	91500	0.282591	0.000042	0.000290	0.000001	0.006705	0.000040	4288	51	9	−6.4	1.6
JAN14A66	91500	0.282479	0.000032	0.000280	0.000002	0.006355	0.000066	5354	62	11	−10.4	1.3
JAN14A67	91500	0.282560	0.000024	0.000285	0.000001	0.006649	0.000038	6252	73	13	−7.5	1.0
Average N = 6		0.282441	0.000032	0.000291	0.000001	0.006790	0.000036	76,314.7	914.5442	164.9912	−11.7	1.2
Standard Zircon GJ-1 as Unknown (Reference ¹⁷⁶ Hf/ ¹⁷⁷ Hf Value = 0.282000 ± 23, 2SD [101])												
JAN14A64	GJ-1	0.282045	0.000027	0.000259	0.000001	0.005945	0.000035	6369	66	12	−25.7	1.1
JAN14A65	GJ-1	0.282150	0.000021	0.000260	0.000000	0.005962	0.000019	9239	96	18	−22.0	0.9
Average N = 2		0.282097	0.000024	0.000259	0.000000	0.005953	0.000027	7804	81	15	−23.9	1.0

Table A4. LA-ICP-MS zircon U–Pb isotope dating results for samples JS26, JS14-1, and JS14-2 from the Dagushi Gp.

Spot No.	Th	U	Th/U	Isotopic Ratios								Age (Ma)			
	ppm	ppm		$^{207}\text{Pb}/^{206}\text{Pb}$	1σ	$^{207}\text{Pb}/^{235}\text{U}$	1σ	$^{206}\text{Pb}/^{238}\text{U}$	1σ	$^{207}\text{Pb}/^{206}\text{Pb}$	1σ	$^{207}\text{Pb}/^{235}\text{U}$	1σ	$^{206}\text{Pb}/^{238}\text{U}$	1σ
				JS26 (Coarse-grained Meta-Quartz Sandstone)											
JS26-01	176	577	0.3	0.1784	0.0023	12.9316	0.1766	0.5230	0.0062	2639	21	2675	13	2712	26
JS26-02	134	322	0.4	0.1793	0.0027	12.9745	0.2060	0.5221	0.0065	2646	25	2678	15	2708	27
JS26-03	219	665	0.3	0.1793	0.0026	12.4993	0.1858	0.5027	0.0061	2647	18	2643	14	2626	26
JS26-04	364	798	0.5	0.1795	0.0029	11.8279	0.1908	0.4743	0.0054	2650	27	2591	15	2502	24
JS26-05	267	843	0.3	0.1793	0.0032	12.8253	0.2269	0.5154	0.0064	2647	29	2667	17	2680	27

Table A4. *Cont.*

Spot No.	Th	U	Th/U	Isotopic Ratios						Age (Ma)					
	ppm	ppm		²⁰⁷ Pb/ ²⁰⁶ Pb	1σ	²⁰⁷ Pb/ ²³⁵ U	1σ	²⁰⁶ Pb/ ²³⁸ U	1σ	²⁰⁷ Pb/ ²⁰⁶ Pb	1σ	²⁰⁷ Pb/ ²³⁵ U	1σ	²⁰⁶ Pb/ ²³⁸ U	1σ
JS26-06	136	411	0.3	0.1825	0.0037	13.0676	0.2632	0.5168	0.0069	2676	33	2685	19	2685	29
JS26-07	291	721	0.4	0.1767	0.0035	12.5000	0.2572	0.5085	0.0068	2622	32	2643	19	2650	29
JS26-08	84.8	239	0.4	0.1975	0.0040	14.0721	0.2982	0.5130	0.0069	2805	33	2755	20	2670	29
JS26-09	206	579	0.4	0.1803	0.0033	13.3069	0.2550	0.5321	0.0074	2655	31	2702	18	2750	31
JS26-10	79.2	212	0.4	0.1825	0.0037	13.0914	0.2671	0.5178	0.0070	2676	33	2686	19	2690	30
JS26-11	116	93.9	1.2	0.2099	0.0049	16.3923	0.3844	0.5655	0.0081	2905	38	2900	22	2889	33
JS26-12	152	450	0.3	0.1788	0.0037	12.9467	0.2666	0.5222	0.0066	2643	34	2676	19	2708	28
JS26-13	163	364	0.4	0.1833	0.0038	13.3961	0.2850	0.5265	0.0069	2682	34	2708	20	2727	29
JS26-14	173	286	0.6	0.1610	0.0033	10.7773	0.2255	0.4824	0.0063	2466	34	2504	19	2538	28
JS26-15	58.1	126	0.5	0.1876	0.0041	14.0461	0.3182	0.5405	0.0075	2721	36	2753	21	2786	31
JS26-16	220	633	0.3	0.1926	0.0034	14.5333	0.2636	0.5428	0.0068	2764	30	2785	17	2795	28
JS26-17	303	654	0.5	0.1802	0.0034	13.1500	0.2496	0.5250	0.0067	2655	32	2690	18	2721	28
JS26-18	20.7	54.7	0.4	0.2136	0.0060	16.6589	0.4684	0.5654	0.0096	3000	51	2915	27	2889	39
JS26-19	282	478	0.6	0.1267	0.0027	6.7070	0.1430	0.3812	0.0051	2054	43	2074	19	2082	24
JS26-20	127	401	0.3	0.1774	0.0035	12.9068	0.2590	0.5238	0.0069	2629	32	2673	19	2715	29
JS26-21	222	520	0.4	0.1774	0.0032	12.3463	0.2207	0.5015	0.0060	2629	30	2631	17	2620	26
JS26-22	98.9	234	0.4	0.2039	0.0040	15.5934	0.3216	0.5519	0.0075	2858	32	2852	20	2833	31
JS26-23	239	504	0.5	0.1750	0.0032	12.2054	0.2369	0.5030	0.0064	2606	30	2620	18	2627	27
JS26-24	163	531	0.3	0.1764	0.0035	12.7515	0.2628	0.5218	0.0068	2619	33	2661	19	2707	29
JS26-25	106	330	0.3	0.1788	0.0037	13.0864	0.2782	0.5296	0.0071	2643	34	2686	20	2740	30
JS26-26	332	552	0.6	0.1244	0.0026	6.5617	0.1395	0.3822	0.0052	2020	37	2054	19	2086	24
JS26-27	245	766	0.3	0.1747	0.0030	12.8268	0.2303	0.5306	0.0066	2603	29	2667	17	2744	28
JS26-28	131	163	0.8	0.1802	0.0037	12.8929	0.2792	0.5178	0.0070	2654	34	2672	20	2690	30
JS26-29	245	770	0.3	0.1779	0.0031	13.1151	0.2402	0.5324	0.0066	2635	28	2688	17	2752	28
JS26-30	124	458	0.3	0.1763	0.0033	12.5621	0.2429	0.5152	0.0066	2620	31	2647	18	2679	28
JS26-31	157	464	0.3	0.1751	0.0035	12.6265	0.2644	0.5209	0.0068	2606	33	2652	20	2703	29
JS26-32	149	431	0.3	0.1772	0.0034	12.8077	0.2474	0.5229	0.0067	2627	32	2666	18	2711	28
JS26-33	209	705	0.3	0.1759	0.0030	12.7158	0.2308	0.5223	0.0066	2615	28	2659	17	2709	28
JS26-34	71.3	149	0.5	0.1581	0.0036	10.3641	0.2466	0.4750	0.0067	2435	39	2468	22	2505	29
JS26-35	163	106	1.5	0.1409	0.0038	7.9153	0.2171	0.4079	0.0060	2239	47	2221	25	2205	27
JS26-36	120	193	0.6	0.1919	0.0043	13.6799	0.3137	0.5161	0.0068	2758	37	2728	22	2682	29
JS26-37	28.8	73.1	0.4	0.1841	0.0051	13.0671	0.3689	0.5154	0.0083	2690	45	2685	27	2680	35
JS26-38	305	511	0.6	0.1819	0.0034	13.5033	0.2601	0.5354	0.0068	2670	32	2716	18	2764	28

Table A4. Cont.

Spot No.	Th	U	Th/U	Isotopic Ratios						Age (Ma)					
	ppm	ppm		²⁰⁷ Pb/ ²⁰⁶ Pb	1σ	²⁰⁷ Pb/ ²³⁵ U	1σ	²⁰⁶ Pb/ ²³⁸ U	1σ	²⁰⁷ Pb/ ²⁰⁶ Pb	1σ	²⁰⁷ Pb/ ²³⁵ U	1σ	²⁰⁶ Pb/ ²³⁸ U	1σ
JS26-39	92.9	246	0.4	0.1782	0.0035	13.4623	0.2768	0.5452	0.0077	2637	33	2713	19	2805	32
JS26-40	184	144	1.3	0.1177	0.0031	6.1196	0.1656	0.3750	0.0055	1921	48	1993	24	2053	26
JS26-41	140	443	0.3	0.1739	0.0034	12.6780	0.2558	0.5237	0.0069	2595	32	2656	19	2715	29
JS26-42	113	234	0.5	0.1733	0.0039	12.3381	0.2739	0.5126	0.0071	2590	37	2630	21	2668	30
JS26-43	114	291	0.4	0.1734	0.0037	12.5839	0.2677	0.5226	0.0072	2590	37	2649	20	2710	31
JS26-44	215	459	0.5	0.2063	0.0039	17.5716	0.3461	0.6117	0.0081	2877	31	2967	19	3077	33
JS26-45	169	466	0.4	0.1778	0.0033	13.0506	0.2463	0.5283	0.0069	2632	32	2683	18	2734	29
JS26-46	256	740	0.3	0.1737	0.0031	12.4875	0.2300	0.5173	0.0067	2594	29	2642	17	2688	28
JS26-47	11.8	50.3	0.2	0.2049	0.0060	15.3118	0.4507	0.5458	0.0095	2866	48	2835	28	2808	40
JS26-48	167	490	0.3	0.1739	0.0035	12.5055	0.2574	0.5184	0.0068	2595	33	2643	19	2692	29
JS26-49	128	345	0.4	0.1770	0.0037	12.8091	0.2722	0.5227	0.0071	2625	35	2666	20	2711	30
JS26-50	130	169	0.8	0.1803	0.0039	12.3890	0.2603	0.4979	0.0068	2657	36	2634	20	2605	29
JS26-51	268	348	0.8	0.2174	0.0037	17.9769	0.3200	0.5966	0.0077	2961	−6	2989	17	3016	31
JS26-52	291	493	0.6	0.1905	0.0030	12.8817	0.2397	0.4876	0.0075	2747	26	2671	18	2560	32
JS26-53	191	478	0.4	0.1488	0.0022	9.2644	0.1427	0.4491	0.0054	2332	26	2364	14	2391	24
JS26-54	225	577	0.4	0.1813	0.0024	12.9805	0.1833	0.5161	0.0064	2665	22	2678	13	2683	27
JS26-55	162	435	0.4	0.1790	0.0024	12.6378	0.1818	0.5088	0.0063	2644	23	2653	14	2651	27
JS26-56	328	747	0.4	0.1788	0.0022	11.1839	0.1434	0.4500	0.0050	2642	20	2539	12	2395	22
JS26-57	92.1	129	0.7	0.1147	0.0031	5.2414	0.1444	0.3317	0.0047	1876	49	1859	24	1846	23
JS26-58	103	245	0.4	0.2050	0.0029	15.4939	0.2221	0.5447	0.0064	2866	28	2846	14	2803	27
JS26-59	182	368	0.5	0.1998	0.0028	14.9607	0.2302	0.5395	0.0069	2824	23	2813	15	2781	29
JS26-60	86.2	184	0.5	0.1788	0.0028	12.3345	0.2047	0.4972	0.0065	2642	25	2630	16	2602	28
JS14-1 (Medium-coarse-grained Meta-quartz Sandstone)															
JS14-1-01	567	271	2.1	0.1508	0.0023	8.8459	0.1386	0.4243	0.0055	2355	26	2322	14	2280	25
JS14-1-02	112	188	0.6	0.0957	0.0022	3.8223	0.0882	0.2889	0.0038	1543	43	1597	19	1636	19
JS14-1-03	317	447	0.7	0.0975	0.0017	3.5198	0.0626	0.2606	0.0032	1577	33	1532	14	1493	16
JS14-1-04	425	787	0.5	0.0949	0.0016	3.6276	0.0635	0.2756	0.0034	1528	32	1556	14	1569	17
JS14-1-05	170	330	0.5	0.1764	0.0031	12.3465	0.2224	0.5046	0.0064	2620	30	2631	17	2634	27
JS14-1-06	128	330	0.4	0.1773	0.0034	12.4306	0.2440	0.5057	0.0066	2627	32	2637	18	2638	28
JS14-1-07	258	313	0.8	0.0950	0.0021	3.6545	0.0855	0.2776	0.0039	1529	43	1561	19	1579	20
JS14-1-08	186	456	0.4	0.1354	0.0023	7.7327	0.1367	0.4120	0.0054	2169	30	2200	16	2224	25
JS14-1-09	278	394	0.7	0.0985	0.0018	3.7681	0.0705	0.2768	0.0036	1595	34	1586	15	1575	18
JS14-1-10	329	922	0.4	0.1788	0.0024	12.4490	0.1788	0.5018	0.0061	2643	22	2639	13	2621	26

Table A4. Cont.

Spot No.	Th	U	Th/U	Isotopic Ratios						Age (Ma)					
	ppm	ppm		²⁰⁷ Pb/ ²⁰⁶ Pb	1σ	²⁰⁷ Pb/ ²³⁵ U	1σ	²⁰⁶ Pb/ ²³⁸ U	1σ	²⁰⁷ Pb/ ²⁰⁶ Pb	1σ	²⁰⁷ Pb/ ²³⁵ U	1σ	²⁰⁶ Pb/ ²³⁸ U	1σ
JS14-1-11	201	501	0.4	0.2036	0.0026	15.5242	0.2131	0.5501	0.0066	2855	21	2848	13	2826	27
JS14-1-12	397	577	0.7	0.0987	0.0015	3.7787	0.0588	0.2765	0.0034	1600	28	1588	13	1574	17
JS14-1-13	134	661	0.2	0.1133	0.0016	5.2247	0.0817	0.3324	0.0040	1854	26	1857	13	1850	19
JS14-1-14	165	281	0.6	0.1026	0.0021	3.8971	0.0815	0.2745	0.0035	1672	38	1613	17	1563	17
JS14-1-15	164	287	0.6	0.1000	0.0022	3.8973	0.0880	0.2815	0.0037	1625	41	1613	18	1599	19
JS14-1-16	146	218	0.7	0.2533	0.0044	22.2843	0.4101	0.6345	0.0081	3205	28	3196	18	3167	32
JS14-1-17	147	289	0.5	0.1003	0.0023	3.8694	0.0889	0.2795	0.0038	1631	43	1607	19	1589	19
JS14-1-18	333	653	0.5	0.1001	0.0022	3.9440	0.0880	0.2847	0.0038	1628	40	1623	18	1615	19
JS14-1-19	369	489	0.8	0.0912	0.0021	3.0993	0.0735	0.2450	0.0032	1451	44	1433	18	1413	17
JS14-1-20	114	267	0.4	0.1862	0.0036	13.3860	0.2705	0.5195	0.0069	2708	32	2707	19	2697	29
JS14-1-21	197	376	0.5	0.1386	0.0028	7.6630	0.1629	0.3995	0.0053	2210	40	2192	19	2167	24
JS14-1-22	100	178	0.6	0.0992	0.0025	3.8195	0.1010	0.2792	0.0039	1610	48	1597	21	1587	20
JS14-1-23	616	611	1.0	0.2005	0.0036	13.6012	0.2520	0.4899	0.0060	2831	−4	2722	18	2570	26
JS14-1-24	275	253	1.1	0.1004	0.0024	3.9944	0.0959	0.2885	0.0040	1631	44	1633	20	1634	20
JS14-1-25	439	450	1.0	0.1012	0.0023	3.7954	0.0895	0.2716	0.0038	1656	42	1592	19	1549	19
JS14-1-26	126	191	0.7	0.1029	0.0028	4.0177	0.1147	0.2834	0.0042	1677	51	1638	23	1608	21
JS14-1-27	187	363	0.5	0.2024	0.0036	15.8306	0.3049	0.5653	0.0076	2846	30	2867	18	2888	31
JS14-1-28	176	219	0.8	0.0991	0.0022	3.9677	0.0938	0.2898	0.0041	1609	42	1628	19	1640	20
JS14-1-29	141	205	0.7	0.2033	0.0038	15.6861	0.3137	0.5591	0.0079	2853	31	2858	19	2863	33
JS14-1-30	301	478	0.6	0.0968	0.0020	3.8143	0.0806	0.2853	0.0037	1563	238	1596	17	1618	19
JS14-1-31	78.2	184	0.4	0.1008	0.0026	3.9819	0.1101	0.2858	0.0042	1639	48	1631	22	1620	21
JS14-1-32	419	607	0.7	0.0970	0.0019	3.7122	0.0755	0.2770	0.0037	1566	37	1574	16	1576	18
JS14-1-33	93.1	160	0.6	0.1016	0.0027	3.8868	0.1061	0.2779	0.0040	1654	50	1611	22	1581	20
JS14-1-34	662	620	1.1	0.0996	0.0019	3.6683	0.0725	0.2663	0.0035	1617	37	1564	16	1522	18
JS14-1-35	254	609	0.4	0.1623	0.0029	10.3763	0.1953	0.4617	0.0059	2479	30	2469	17	2447	26
JS14-1-37	580	858	0.7	0.1400	0.0027	7.4575	0.1585	0.3837	0.0054	2227	33	2168	19	2094	25
JS14-1-38	212	365	0.6	0.0996	0.0021	3.8566	0.0820	0.2796	0.0037	1617	39	1605	17	1589	19
JS14-1-39	178	453	0.4	0.1914	0.0030	13.3165	0.2171	0.5016	0.0061	2754	26	2702	15	2621	26
JS14-1-40	195	432	0.5	0.1919	0.0028	13.7623	0.2093	0.5171	0.0063	2758	25	2733	14	2687	27
JS14-1-41	361	815	0.4	0.1798	0.0022	12.6775	0.1773	0.5082	0.0066	2652	20	2656	13	2649	28
JS14-1-42	478	574	0.8	0.0971	0.0014	3.8071	0.0640	0.2820	0.0035	1569	28	1594	14	1602	17
JS14-1-43	86.0	155	0.6	0.1018	0.0025	4.0389	0.1033	0.2872	0.0041	1658	46	1642	21	1628	20
JS14-1-44	231	275	0.8	0.0992	0.0019	3.8168	0.0773	0.2777	0.0037	1610	41	1596	16	1580	19
JS14-1-45	110	284	0.4	0.1006	0.0019	3.9248	0.0772	0.2819	0.0037	1635	36	1619	16	1601	18
JS14-1-46	124	232	0.5	0.1000	0.0024	3.9205	0.0958	0.2832	0.0039	1633	44	1618	20	1607	20

Table A4. Cont.

Spot No.	Th	U	Th/U	Isotopic Ratios						Age (Ma)					
	ppm	ppm		²⁰⁷ Pb/ ²⁰⁶ Pb	1σ	²⁰⁷ Pb/ ²³⁵ U	1σ	²⁰⁶ Pb/ ²³⁸ U	1σ	²⁰⁷ Pb/ ²⁰⁶ Pb	1σ	²⁰⁷ Pb/ ²³⁵ U	1σ	²⁰⁶ Pb/ ²³⁸ U	1σ
JS14-1-47	187	331	0.6	0.1030	0.0022	3.9315	0.0864	0.2762	0.0037	1680	39	1620	18	1572	19
JS14-1-48	221	537	0.4	0.1813	0.0035	12.6261	0.2520	0.5019	0.0066	2665	33	2652	19	2622	28
JS14-1-49	124	309	0.4	0.1359	0.0029	7.3882	0.1619	0.3922	0.0051	2176	37	2160	20	2133	24
JS14-1-50	417	797	0.5	0.1008	0.0019	3.8209	0.0756	0.2734	0.0035	1639	35	1597	16	1558	17
JS14-1-51	541	821	0.7	0.1237	0.0022	5.9527	0.1217	0.3464	0.0048	2010	33	1969	18	1917	23
JS14-1-52	1976	1305	1.5	0.1380	0.0024	6.2957	0.1176	0.3292	0.0046	2203	30	2018	16	1834	22
JS14-1-53	282	399	0.7	0.0997	0.0022	3.7646	0.0833	0.2733	0.0038	1620	42	1585	18	1558	19
JS14-1-54	127	369	0.3	0.1827	0.0037	12.9191	0.2673	0.5101	0.0067	2680	33	2674	20	2657	28
JS14-1-56	779	1436	0.5	0.0991	0.0019	3.7319	0.0747	0.2714	0.0034	1609	36	1578	16	1548	17
JS14-1-57	471	562	0.8	0.0995	0.0020	3.8234	0.0798	0.2771	0.0036	1617	38	1598	17	1577	18
JS14-1-58	2674	1198	2.2	0.0977	0.0019	3.0563	0.0649	0.2256	0.0033	1581	36	1422	16	1311	17
JS14-1-59	160	324	0.5	0.1350	0.0026	7.2039	0.1438	0.3852	0.0053	2165	33	2137	18	2100	25
JS14-1-60	388	499	0.8	0.0992	0.0019	3.8732	0.0805	0.2813	0.0037	1609	42	1608	17	1598	19
JS14-1-61	242	246	1.0	0.1216	0.0028	6.1767	0.1459	0.3658	0.0049	1981	41	2001	21	2010	23
JS14-1-62	217	383	0.6	0.0987	0.0024	3.9299	0.0950	0.2873	0.0038	2000	51	1620	20	1628	19
JS14-1-63	289	378	0.8	0.1013	0.0026	3.9147	0.0994	0.2783	0.0039	1648	48	1617	21	1583	19
JS14-1-64	70.3	106	0.7	0.1893	0.0049	13.7514	0.3560	0.5226	0.0076	2737	48	2733	25	2710	32
JS14-1-65	499	482	1.0	0.0997	0.0023	3.8376	0.0894	0.2762	0.0036	1618	43	1601	19	1572	18
JS14-1-66	116	195	0.6	0.0995	0.0027	4.0719	0.1109	0.2950	0.0044	1617	50	1649	22	1666	22
JS14-1-67	358	422	0.86	0.0987	0.0023	3.8628	0.0893	0.2809	0.0036	2000	38	1606	19	1596	18
JS14-1-68	396	482	0.86	0.1007	0.0024	3.9829	0.0926	0.2844	0.0037	1639	43	1631	19	1614	19
JS14-1-69	164	461	0.4	0.1851	0.0042	13.4459	0.3149	0.5215	0.0073	2700	38	2711	22	2705	31
JS14-1-70	113	272	0.4	0.2159	0.0052	16.9700	0.4043	0.5652	0.0077	2950	39	2933	23	2888	32
JS14-1-71	214	410	0.5	0.0981	0.0024	3.8689	0.0953	0.2833	0.0038	1588	45	1607	20	1608	19
JS14-1-72	1193	858	1.4	0.0982	0.0021	3.8954	0.0849	0.2847	0.0038	1591	41	1613	18	1615	19
JS14-1-73	164	424	0.4	0.1852	0.0038	13.4894	0.2754	0.5229	0.0065	2702	33	2715	19	2711	28
JS14-1-74	239	601	0.4	0.1807	0.0035	12.8931	0.2617	0.5124	0.0070	2659	31	2672	19	2667	30
JS14-1-75	111	205	0.5	0.0985	0.0029	3.8368	0.1107	0.2820	0.0039	1595	56	1601	23	1601	20
JS14-2 (Medium-coarse-grained Meta-quartz Sandstone)															
JS14-2-1	152	484	0.3	0.1316	0.0017	6.6251	0.1102	0.3617	0.0041	2120	22	2063	15	1990	20
JS14-2-2	137	67	2.1	0.1006	0.0021	3.9675	0.0812	0.2856	0.0034	1635	37	1628	17	1620	17
JS14-2-3	18	72	0.2	0.1479	0.0027	9.0198	0.1745	0.4388	0.0046	2321	31	2340	18	2345	21
JS14-2-4	84	98	0.9	0.0995	0.0019	3.9210	0.0735	0.2841	0.0029	1617	35	1618	15	1612	15

Table A4. Cont.

Spot No.	Th	U	Th/U	Isotopic Ratios						Age (Ma)					
	ppm	ppm		²⁰⁷ Pb/ ²⁰⁶ Pb	1σ	²⁰⁷ Pb/ ²³⁵ U	1σ	²⁰⁶ Pb/ ²³⁸ U	1σ	²⁰⁷ Pb/ ²⁰⁶ Pb	1σ	²⁰⁷ Pb/ ²³⁵ U	1σ	²⁰⁶ Pb/ ²³⁸ U	1σ
JS14-2-5	89	148	0.6	0.0978	0.0018	3.8619	0.0728	0.2843	0.0030	1583	35	1606	15	1613	15
JS14-2-6	46	81	0.6	0.1881	0.0034	13.9450	0.2581	0.5336	0.0063	2725	30	2746	18	2756	26
JS14-2-7	184	190	1.0	0.1412	0.0024	8.1466	0.1448	0.4151	0.0050	2243	30	2247	16	2238	23
JS14-2-8	236	165	1.4	0.1953	0.0029	13.5167	0.2064	0.4969	0.0042	2787	24	2716	15	2600	18
JS14-2-9	48	86	0.6	0.1018	0.0020	3.9292	0.0818	0.2785	0.0030	1657	37	1620	17	1584	15
JS14-2-10	168	225	0.7	0.1352	0.0020	7.4124	0.1319	0.3942	0.0045	2169	25	2162	16	2142	21
JS14-2-11	130	224	0.6	0.1776	0.0026	12.0654	0.1906	0.4900	0.0044	2631	25	2610	15	2571	19
JS14-2-12	80	102	0.8	0.0994	0.0021	3.9278	0.0861	0.2859	0.0031	1613	39	1619	18	1621	15
JS14-2-13	114	131	0.9	0.0976	0.0020	3.8802	0.0836	0.2878	0.0030	1589	38	1610	17	1631	15
JS14-2-14	304	515	0.6	0.0959	0.0014	3.4670	0.0543	0.2610	0.0019	1546	28	1520	12	1495	10
JS14-2-15	45	81	0.6	0.1029	0.0021	4.1844	0.0934	0.2940	0.0032	1676	38	1671	18	1662	16
JS14-2-16	57	93	0.6	0.1089	0.0022	4.3012	0.0941	0.2851	0.0029	1783	36	1694	18	1617	15
JS14-2-17	98	108	0.9	0.0971	0.0019	3.8585	0.0786	0.2874	0.0029	1570	36	1605	16	1629	15
JS14-2-18	574	313	1.8	0.1187	0.0018	4.8443	0.0790	0.2946	0.0027	1937	28	1793	14	1665	13
JS14-2-19	247	322	0.8	0.1319	0.0020	7.1390	0.1182	0.3905	0.0036	2124	26	2129	15	2125	17
JS14-2-20	247	171	1.4	0.0987	0.0017	3.8598	0.0685	0.2821	0.0026	1600	31	1605	14	1602	13
JS14-2-21	172	193	0.9	0.1394	0.0020	7.9578	0.1202	0.4120	0.0036	2220	25	2226	14	2224	17
JS14-2-22	850	350	2.4	0.1429	0.0019	8.3987	0.1165	0.4238	0.0034	2262	23	2275	13	2278	16
JS14-2-23	33	83	0.4	0.1810	0.0029	13.2559	0.2338	0.5279	0.0056	2662	27	2698	17	2733	24
JS14-2-24	69	146	0.5	0.1870	0.0031	13.6770	0.2431	0.5269	0.0054	2716	27	2728	17	2728	23
JS14-2-25	183	369	0.5	0.0979	0.0016	3.8415	0.0663	0.2829	0.0029	1584	30	1601	14	1606	15
JS14-2-26	102	148	0.7	0.0972	0.0018	3.7338	0.0680	0.2775	0.0026	1572	34	1579	15	1579	13
JS14-2-27	146	221	0.7	0.1942	0.0027	14.6311	0.2145	0.5425	0.0048	2789	56	2792	14	2794	20
JS14-2-28	135	209	0.6	0.1768	0.0026	11.9383	0.1747	0.4868	0.0040	2623	24	2600	14	2557	17
JS14-2-29	20	44	0.4	0.0991	0.0028	3.9989	0.1182	0.2931	0.0043	1609	54	1634	24	1657	21
JS14-2-30	1182	553	2.1	0.1224	0.0021	4.4443	0.1004	0.2614	0.0043	1992	36	1721	19	1497	22

Note: Concordance (conc.) = (²⁰⁶Pb/²³⁸U age)/(²⁰⁷Pb/²³⁵U age) × 100%.

Table A5. LA-ICP-MS zircon Hf isotope analyses for sample JS14-1 from the Dagushi Gp.

Spot Position	$^{176}\text{Hf}/^{177}\text{Hf}$	1 σ	$^{176}\text{Lu}/^{177}\text{Hf}$	1 σ	$^{176}\text{Yb}/^{177}\text{Hf}$	1 σ	$\epsilon\text{Hf}(0)$	Age (Ma)	$(^{176}\text{Hf}/^{177}\text{Hf})_i$	$\epsilon\text{Hf}(t)$ ^(a)	1 σ	T_{DM1} (Ma) ^(b)	1 σ	$f_{\text{Lu/Hf}}$ ^(d)	T_{DM2} (Ma) ^(c)	1 σ
JS14-1-8	0.28137	0.000009	0.000609	0.000002	0.015213	0.000047	−49.6	2169	0.281345	−2	0.33	2601	25	−0.98	2778	36
JS14-1-9	0.281831	0.000013	0.001155	0.000017	0.030212	0.000526	−33.3	1595	0.281796	1	0.44	2003	35	−0.97	2162	48
JS14-1-10	0.281118	0.000012	0.000614	0.000001	0.015143	0.000036	−58.5	2643	0.281087	−0.2	0.41	2939	31	−0.98	3061	44
JS14-1-11	0.280988	0.000009	0.000974	0.000011	0.026265	0.000438	−63.1	2855	0.280935	−0.7	0.33	3143	25	−0.97	3257	35
JS14-1-12	0.281841	0.000012	0.001618	0.000006	0.041546	0.000163	−32.9	1600	0.281792	1	0.42	2013	33	−0.95	2166	45
JS14-1-15	0.281831	0.000014	0.001161	0.000006	0.029219	0.000109	−33.3	1625	0.281796	1.6	0.48	2002	38	−0.97	2149	52
JS14-1-20	0.281142	0.000015	0.001009	0.000026	0.025892	0.000684	−57.6	2708	0.28109	1.4	0.53	2938	40	−0.97	3028	56
JS14-1-21	0.281385	0.00001	0.000902	0.000029	0.022993	0.000791	−49.1	2210	0.281347	−0.9	0.35	2600	27	−0.97	2756	38
JS14-1-22	0.281721	0.00001	0.000387	0.000001	0.010348	0.000015	−37.2	1610	0.281709	−1.8	0.36	2112	27	−0.99	2322	39
JS14-1-27	0.280968	0.00001	0.000575	0.000003	0.013891	0.000072	−63.8	2846	0.280937	−0.8	0.36	3137	27	−0.98	3257	38
JS14-1-29	0.280979	0.000013	0.000383	0.000002	0.009072	0.000056	−63.4	2853	0.280958	0.1	0.45	3107	34	−0.99	3213	48
JS14-1-30	0.28177	0.000009	0.000349	0.000003	0.008611	0.000068	−35.4	1563	0.281759	−1.1	0.33	2044	25	−0.99	2246	36
JS14-1-31	0.281758	0.000011	0.000826	0.000019	0.021909	0.000497	−35.9	1639	0.281732	−0.3	0.38	2086	29	−0.98	2265	41
JS14-1-33	0.281788	0.000011	0.000831	0.000003	0.021656	0.000042	−34.8	1654	0.281762	1.1	0.39	2045	30	−0.97	2202	42
JS14-1-38	0.281852	0.000012	0.001548	0.000012	0.041435	0.000384	−32.5	1617	0.281804	1.8	0.42	1995	34	−0.95	2136	46
JS14-1-41	0.28109	0.00001	0.000642	0.000002	0.015934	0.000062	−59.5	2652	0.281057	−1.1	0.34	2980	26	−0.98	3114	36
JS14-1-42	0.281827	0.000012	0.001058	0.000004	0.028237	0.00013	−33.4	1569	0.281796	0.4	0.43	2003	33	−0.97	2174	47
JS14-1-43	0.281777	0.000014	0.000702	0.000019	0.018293	0.000519	−35.2	1658	0.281755	0.9	0.5	2053	39	−0.98	2214	55
JS14-1-44	0.281811	0.000012	0.001651	0.000018	0.042405	0.000551	−34	1610	0.281761	0.1	0.41	2057	32	−0.95	2223	44
JS14-1-45	0.281776	0.000011	0.000389	0.000001	0.010064	0.000012	−35.2	1635	0.281764	0.8	0.37	2037	28	−0.99	2205	40
JS14-1-46	0.281802	0.000012	0.001123	0.000008	0.029011	0.000225	−34.3	1633	0.281767	0.8	0.44	2042	34	−0.97	2201	47
JS14-1-48	0.281113	0.00001	0.000665	0.000002	0.01675	0.000044	−58.7	2665	0.281079	0	0.34	2951	26	−0.98	3067	36
JS14-1-49	0.281349	0.00001	0.00055	0.000005	0.013541	0.000137	−50.3	2176	0.281326	−2.5	0.36	2625	27	−0.98	2810	38
JS14-1-53	0.281799	0.000013	0.001367	0.000012	0.037372	0.000319	−34.4	1620	0.281757	0.2	0.45	2059	35	−0.96	2226	48
JS14-1-54	0.28109	0.00001	0.000686	0.000006	0.01732	0.000181	−59.5	2680	0.281054	−0.5	0.36	2984	27	−0.98	3107	38
JS14-1-56	0.281774	0.00001	0.001214	0.000028	0.033927	0.000826	−35.3	1609	0.281737	−0.8	0.37	2085	29	−0.96	2269	40
JS14-1-57	0.281842	0.00001	0.001279	0.000049	0.033601	0.001362	−32.9	1617	0.281803	1.7	0.36	1994	28	−0.96	2139	39
JS14-1-65	0.281831	0.000011	0.001248	0.000002	0.031292	0.000082	−33.3	1618	0.281793	1.4	0.41	2008	32	−0.96	2158	44
JS14-1-69	0.281097	0.00001	0.00054	0.000003	0.013527	0.000095	−59.2	2700	0.281069	0.5	0.35	2962	26	−0.98	3070	37
JS14-1-72	0.281853	0.000011	0.002498	0.000051	0.065916	0.001474	−32.5	1591	0.281778	0.2	0.38	2045	31	−0.92	2199	42
JS14-1-73	0.281073	0.00001	0.000574	0.000009	0.014528	0.000254	−60.1	2702	0.281043	−0.4	0.37	2998	28	−0.98	3119	39
JS14-1-74	0.281097	0.00001	0.000666	0.000001	0.016486	0.000027	−59.2	2659	0.281063	−0.7	0.37	2972	28	−0.98	3100	39
JS14-1-75	0.281765	0.000011	0.000714	0.000004	0.018449	0.000085	−35.6	1595	0.281744	−0.9	0.38	2070	29	−0.98	2262	41

$\lambda_{\text{Lu-Hf}} = 1.867 \times 10^{-11} \text{ year}^{-1}$; ^(a) $\epsilon\text{Hf}(t) = [(^{176}\text{Hf}/^{177}\text{Hf})_{\text{Sample}t} / (^{176}\text{Hf}/^{177}\text{Hf})_{\text{CHUR}t} - 1] \times 10^4$; ^(b) $T_{\text{DM1}} = 1/\lambda \times \ln [1 + ((^{176}\text{Hf}/^{177}\text{Hf})_{\text{Sample}0} - (^{176}\text{Hf}/^{177}\text{Hf})_{\text{DM}0}) / ((^{176}\text{Lu}/^{177}\text{Hf})_{\text{Sample}0} - (^{176}\text{Lu}/^{177}\text{Hf})_{\text{DM}0})]$; ^(c) $T_{\text{DM2}} = T_{\text{DM1}} - (T_{\text{DM1}} - t) \times [(f_{\text{CC}} - f_{\text{S}}) / (f_{\text{CC}} - f_{\text{DM}})]$; ^(d) $f_{\text{Lu/Hf}} = [(^{176}\text{Lu}/^{177}\text{Hf})_{\text{Source}} / (^{176}\text{Lu}/^{177}\text{Hf})_{\text{CHUR},0}] - 1$; $(^{176}\text{Lu}/^{177}\text{Hf})_{\text{CHUR},0} = 0.0332 \pm 2$, $(^{176}\text{Hf}/^{177}\text{Hf})_{\text{CHUR},0} = 0.282772 \pm 29$; $(^{176}\text{Lu}/^{177}\text{Hf})_{\text{DM}} = 0.0384$, $(^{176}\text{Hf}/^{177}\text{Hf})_{\text{DM}} = 0.28325$, $(^{176}\text{Lu}/^{177}\text{Hf})_{\text{mean crust}} = 0.015$, $f_{\text{CC}} = (0.015/0.0332) - 1 = -0.55$, $f_{\text{DM}} = (0.0384/0.0332) - 1 = 0.165$.

Table A6. Trace element analyses of the ~1.60 Ga detrital zircons for samples JS14-1 and JS14-2 from the Dagushi Gp (ppm).

Spot No.	Ti	Y	Nb	Ce	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
JS14-1-2	14	1128	3	7	11	15	7	57	15	140	43	156	28	246	43	6143	1	36	57
JS14-1-3	8	1247	13	23	6	9	2	42	13	140	47	186	36	313	56	6592	4	111	145
JS14-1-4	12	683	6	18	2	3	0	18	6	65	24	102	21	200	37	9331	3	147	253
JS14-1-7	9	1703	29	102	4	7	3	35	13	152	59	263	54	504	93	6034	6	91	101
JS14-1-9	10	1561	20	60	7	12	5	53	16	169	57	230	44	386	68	6663	5	90	117
JS14-1-12	6	2463	36	88	9	13	5	66	22	253	89	369	72	636	111	7287	7	146	198
JS14-1-14	13	1064	6	1137	743	142	13	134	21	153	42	142	25	216	37	8190	3	56	90
JS14-1-15	6	1027	28	90	3	5	2	25	9	103	38	157	31	275	48	6393	6	58	94
JS14-1-17	13	994	19	51	4	6	2	27	9	101	36	152	30	273	50	7219	7	54	97
JS14-1-18	8	784	12	25	2	3	0	17	6	71	27	123	26	257	49	10,565	5	120	219
JS14-1-19	8	2531	13	29	14	23	4	95	27	289	96	371	69	590	100	6801	4	138	169
JS14-1-22	24	561	5	9	3	6	1	21	7	67	22	84	16	143	24	8226	3	36	60
JS14-1-24	10	1922	13	76	7	12	3	53	19	207	72	295	58	522	91	7791	4	105	88
JS14-1-25	10	1169	29	103	4	7	3	34	11	122	43	173	33	294	50	6596	7	158	152
JS14-1-26	18	815	17	73	2	3	1	14	6	68	28	129	28	264	49	6893	4	46	65
JS14-1-28	8	1222	18	121	19	9	2	28	10	113	43	190	40	362	66	7072	5	66	76
JS14-1-30	19	466	3	19	1	3	0	11	4	43	16	69	15	143	26	9801	2	112	166
JS14-1-31	13	643	7	10	4	6	3	26	7	75	24	94	17	151	27	7997	2	29	64
JS14-1-32	7	1309	14	24	9	10	2	45	14	148	50	193	35	291	48	8024	4	154	209
JS14-1-33	18	1096	2	7	11	14	7	54	14	135	43	154	28	241	43	7068	1	34	55
JS14-1-34	11	1723	44	737	268	59	14	93	21	196	64	249	47	396	67	6893	9	244	214
JS14-1-38	11	1123	24	70	4	7	3	31	10	115	41	168	34	306	55	7682	7	82	130
JS14-1-42	9	1234	36	114	3	6	3	31	11	121	45	187	37	325	57	6958	8	180	201
JS14-1-43	12	1039	3	7	9	14	6	52	13	129	40	147	27	234	41	7519	1	34	55
JS14-1-45	6	584	11	18	3	4	1	19	6	64	22	87	17	150	26	9042	4	41	99
JS14-1-46	6	748	9	23	4	6	1	25	8	82	28	113	22	198	36	6546	3	46	81
JS14-1-47	16	1592	7	10	11	17	7	73	20	194	62	232	42	364	64	7591	3	73	120
JS14-1-50	7	1001	15	47	10	6	1	23	8	92	36	159	34	326	62	12,092	6	166	295
JS14-1-53	6	1003	17	25	3	7	2	37	12	117	39	152	29	258	45	7625	5	111	144

Table A6. *Cont.*

Spot No.	Ti	Y	Nb	Ce	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Th	U
JS14-1-56	4	2084	26	895	508	114	2	147	31	267	82	308	57	478	79	9597	9	308	532
JS14-1-57	12	1359	35	117	5	8	3	35	12	138	50	207	41	362	63	8013	8	189	207
JS14-1-58	51	4816	16	48	54	122	50	437	102	756	187	612	105	851	139	7149	3	1029	439
JS14-1-60	7	1579	45	288	56	14	4	40	14	155	57	243	48	428	76	7508	9	164	187
JS14-1-63	21	2005	18	70	9	14	5	59	21	227	80	319	64	512	88	7342	6	113	136
JS14-1-65	11	1274	30	134	3	6	2	28	10	121	47	208	47	420	79	7800	7	196	174
JS14-1-66	21	1072	3	9	6	8	3	40	12	124	43	169	35	287	53	8654	1	47	72
JS14-1-68	6	1362	38	199	35	13	4	41	13	145	54	215	44	359	64	7444	9	158	176
JS14-1-71	3	1396	17	417	247	55	3	84	18	172	58	222	43	354	64	7272	5	88	153
JS14-1-72	12	2125	50	228	4	9	4	49	17	204	79	339	73	629	118	7241	12	479	315
JS14-1-75	6	691	9	26	3	6	1	27	8	82	29	110	22	189	35	7209	3	46	78
JS14-2-2	10	522	7	9	8	9	6	30	8	77	23	83	16	127	21	5349	3	146	67
JS14-2-4	7	1001	20	88	2	4	1	20	7	87	35	163	36	327	62	7996	5	91	100
JS14-2-5	8	993	8	16	4	7	1	36	11	116	39	152	29	236	42	9450	3	99	154
JS14-2-9	11	1540	5	11	10	17	8	97	29	229	62	207	38	298	51	8566	2	53	89
JS14-2-12	8	1169	25	95	2	4	2	22	8	102	42	188	43	385	73	7475	6	88	106
JS14-2-13	27	831	3	17	5	7	1	30	8	89	30	121	26	220	40	9480	1	127	136
JS14-2-14	6	3069	14	17	12	24	3	113	34	349	119	455	87	673	112	10,350	5	346	552
JS14-2-15	50	1078	8	17	13	14	5	53	14	136	42	157	30	245	44	7944	3	50	84
JS14-2-17	7	1004	20	94	2	4	1	21	7	87	36	161	36	328	62	8113	5	108	112
JS14-2-20	11	1763	33	259	44	15	4	47	15	171	64	274	58	506	91	6912	7	268	176
JS14-2-25	5	1145	19	16	3	7	0	33	11	124	44	179	36	298	50	10,250	6	206	396
JS14-2-26	12	2365	10	18	22	32	12	130	34	315	97	341	63	497	85	8189	4	119	161
JS14-2-29	27	394	6	18	7	3	1	14	4	46	15	59	13	108	19	8614	2	22	48

References

1. Rogers, J.J.W.; Santosh, M. Configuration of Columbia, a Mesoproterozoic Supercontinent. *Gondwana Res.* **2002**, *5*, 5–22. [\[CrossRef\]](#)
2. Zhao, G.; Cawood, P.A.; Wilde, S.A.; Sun, M. Review of global 2.1–1.8 Ga orogens: Implications for a pre-Rodinia supercontinent. *Earth Sci. Rev.* **2002**, *59*, 125–162. [\[CrossRef\]](#)
3. Evans, D.A.D.; Mitchell, R.N. Assembly and breakup of the core of Paleoproterozoic–Mesoproterozoic supercontinent Nuna. *Geology* **2011**, *39*, 443–446. [\[CrossRef\]](#)
4. Zhao, G.C.; Cawood, P.A. Precambrian geology of China. *Precambrian Res.* **2012**, *222*, 13–54. [\[CrossRef\]](#)
5. Meert, J.G.; Santosh, M. The Columbia supercontinent revisited. *Gondwana Res.* **2017**, *50*, 67–83. [\[CrossRef\]](#)
6. Zhao, G.C.; Sun, M.; Wilde, S.A.; Li, S.Z. A Paleo–Mesoproterozoic supercontinent: Assembly, growth and breakup. *Earth Sci. Rev.* **2004**, *67*, 91–123. [\[CrossRef\]](#)
7. Pisarevsky, S.A.; Elming, S.Å.; Pesonen, L.J.; Li, Z.X. Mesoproterozoic paleogeography: Supercontinent and beyond. *Precambrian Res.* **2014**, *244*, 207–225. [\[CrossRef\]](#)
8. Fan, H.P.; Zhu, W.G.; Li, Z.X.; Zhong, H.; Bai, Z.J.; He, D.F.; Chen, C.J.; Cao, C.Y. Ca. 1.5 Ga mafic magmatism in South China during the break-up of the supercontinent Nuna/Columbia: The Zhuqing Fe–Ti–V oxide ore-bearing mafic intrusions in western Yangtze Block. *Lithos* **2013**, *168–169*, 85–98. [\[CrossRef\]](#)
9. Condie, K.C.; Belousova, E.; Griffin, W.L.; Sircombe, K.N. Granitoid events in space and time: Constraints from igneous and detrital zircon age spectra. *Gondwana Res.* **2009**, *15*, 228–242. [\[CrossRef\]](#)
10. Guan, J.L.; Zheng, L.L.; Liu, J.H.; Sun, Z.M.; Cheng, W.H. Zircon SHRIMP U–Pb Dating of Diabase from Hekou, Sichuan Province, China and Its Geological Significance. *Acta Geol. Sin.* **2011**, *85*, 482–490.
11. Chen, W.T.; Zhou, M.F.; Zhao, X.F. Late Paleoproterozoic sedimentary and mafic rocks in the Hekou area, SW China: Implication for the reconstruction of the Yangtze Block in Columbia. *Precambrian Res.* **2013**, *231*, 61–77. [\[CrossRef\]](#)
12. Hou, L.; Ding, J.; Deng, J.; Peng, H.J. Geology, geochronology, and geochemistry of the Yinachang Fe–Cu–Au–REE deposit of the Kangdian region of SW China: Evidence for a Paleo–Mesoproterozoic tectono-magmatic event and associated IOCG systems in the western Yangtze Block. *J. Asian Earth Sci.* **2015**, *103*, 129–149. [\[CrossRef\]](#)
13. Greentree, M.R.; Li, Z.X. The oldest known rocks in south-western China: SHRIMP U–Pb magmatic crystallisation age and detrital provenance analysis of the Paleoproterozoic Dahongshan Group. *J. Asian Earth Sci.* **2008**, *33*, 289–302. [\[CrossRef\]](#)
14. Zhao, X.F.; Zhou, M.F.; Li, J.W.; Sun, M.; Gao, J.F.; Sun, W.H.; Yang, J.H. Late Paleoproterozoic to early Mesoproterozoic Dongchuan Group in Yunnan, SW China: Implications for tectonic evolution of the Yangtze Block. *Precambrian Res.* **2010**, *182*, 57–69. [\[CrossRef\]](#)
15. Wang, W.; Zhou, M.F. Provenance and tectonic setting of the Paleo-to Mesoproterozoic Dongchuan Group in the southwestern Yangtze Block, South China: Implication for the breakup of the supercontinent Columbia. *Tectonophysics* **2014**, *610*, 110–127. [\[CrossRef\]](#)
16. Wang, W.; Zhou, M.F.; Zhao, X.F.; Chen, W.T.; Yan, D.P. Late Paleoproterozoic to Mesoproterozoic rift successions in SW China: Implication for the Yangtze Block–North Australia–Northwest Laurentia connection in the Columbia supercontinent. *Sediment. Geol.* **2014**, *309*, 33–47. [\[CrossRef\]](#)
17. Xiong, X.W.; Chen, Y.Y. Sedimentary features and its significance of tectono-paleogeography of Dagushi Group, Jingshan, Hubei province. *Earth Sci. J. China Univ. Geosci.* **1991**, *16*, 489–495. (In Chinese)
18. Xiao, Z.B. Research of the Detrital Zircon from Mesoproterozoic Sedimentary Strata in the North Margin of Yangtze Craton, China. Master’s Thesis, Northwest University, Xi’an, China, 2012.
19. Li, H.K.; Tian, H.; Zhou, H.Y.; Zhang, J.; Liu, H.; Geng, J.Z.; Ye, L.J.; Xiang, Z.Q.; Qu, Y.S. Correlation between the Dagushi Group in the Dahongshan Area and the Shennongjia Group in the Shennongjia Area on the northern margin of the Yangtze Craton: Constraints from zircon U–Pb ages and Lu–Hf isotopic systematics. *Earth Sci. Front.* **2016**, *23*, 186–201.
20. Yang, Z.N. The Paleoproterozoic to Middle Neoproterozoic Tectonic Evolution of the Suizhou–Yingshan Terrain and Its Surrounding Area in the Northern Yangtze Block. Ph.D. Thesis, Chinese University of Geosciences, Wuhan, China, 2018.
21. Li, H.K.; Zhang, C.L.; Xiang, Z.Q.; Lu, S.N.; Zhang, J.; Geng, J.Z.; Qu, L.S.; Wang, Z.X. Zircon and baddeleyite U–Pb geochronology of the Shennongjia Group in the Yangtze Craton and its tectonic significance. *Acta Petrol. Sin.* **2013**, *29*, 673–697.
22. Du, Q.D.; Wang, Z.J.; Wang, J.; Deng, Q.; Yang, F. Geochronology and geochemistry of tuff beds from the Shicaohe Formation of Shennongjia Group and tectonic evolution in the northern Yangtze Block, South China. *Int. J. Earth Sci.* **2016**, *105*, 521–535. [\[CrossRef\]](#)
23. Qiu, X.F.; Yang, H.M.; Lu, S.S.; Ling, W.L.; Zhang, L.G.; Tan, J.J.; Wang, Z.X. Geochronology and geochemistry of Grenville-aged (1063 ± 16 Ma) metabasalts in the Shennongjia district, Yangtze block: Implications for tectonic evolution of the South China Craton. *Int. Geol. Rev.* **2015**, *57*, 76–96. [\[CrossRef\]](#)
24. Wang, L.J.; Griffin, W.L.; Yu, J.H.; O’Reilly, S.Y. U–Pb and Lu–Hf isotopes in detrital zircon from Neoproterozoic sedimentary rocks in the northern Yangtze Block: Implications for Precambrian crustal evolution. *Gondwana Res.* **2013**, *23*, 1261–1272. [\[CrossRef\]](#)
25. Wu, Y.B.; Gao, S.; Gong, H.J.; Xiang, H.; Jiao, W.F.; Yang, S.H.; Liu, Y.S.; Yuan, H.L. Zircon U–Pb age, trace element and Hf isotope composition of Kongling terrane in the Yangtze Craton: Refining the timing of Palaeoproterozoic high-grade metamorphism. *J. Metamorph. Geol.* **2009**, *27*, 461–477. [\[CrossRef\]](#)

26. Yang, Z.N.; Yang, K.G.; Polat, A.; Xu, Y. Early crustal evolution of the eastern Yangtze Block: Evidence from detrital zircon U-Pb ages and Hf isotopic composition of the Neoproterozoic Huashan Group in the Dahongshan Area. *Precambrian Res.* **2018**, *309*, 248–270. [\[CrossRef\]](#)
27. Du, Q.D.; Wang, Z.J.; Wang, J.; Qiu, Y.S.; Jiang, X.S.; Deng, Q.; Yang, F. Geochronology and paleoenvironment of the pre-Sturtian glacial strata: Evidence from the Liantuo Formation in the Nanhua rift basin of the Yangtze Block, South China. *Precambrian Res.* **2013**, *233*, 118–131. [\[CrossRef\]](#)
28. Hu, Z.X.; Liu, C.; Mao, X.W.; Deng, Q.Z.; Yang, J.X.; Li, L.J.; Kong, L.Y. Documentation of Jingningian island-arc volcanic rocks and accretionary complexes in the Dahongshan Region, northern Hubei and its tectonic significance. *Resour. Environ. Eng.* **2015**, *29*, 757–766.
29. BGMHRB. *Regional Geological Survey Report (Kedianpo, Guchengfan and Sanyangdian Areas, 1:50,000)*; BGMHRB: Hubei, China, 1986. (In Chinese)
30. Liu, H.; Xu, D.L.; Wei, Y.X.; Deng, X.; Peng, L.H. Depositional age of the Dagushi Group in the Dahong Mountain, Hubei Province: Evidence from U-Pb ages of detrital zircons. *Geol. Bull. China* **2017**, *36*, 715–725.
31. Wiedenbeck, M.; Allé, P.; Corfu, F.; Griffin, W.L.; Meier, M.; Oberli, F.; Quadt, A.V.; Roddick, J.C.; Spiegel, W. Three natural zircon standards for U-Th-Pb, Lu-Hf, trace element and REE analyses. *Geostand. Newslet.* **1995**, *19*, 1–23. [\[CrossRef\]](#)
32. Jackson, S.E.; Pearson, N.J.; Griffin, W.L.; Belousova, E.A. The application of laser ablation-inductively coupled plasma-mass spectrometry to in situ U-Pb zircon geochronology. *Chem. Geol.* **2004**, *211*, 47–69. [\[CrossRef\]](#)
33. Liu, Y.S.; Hu, Z.C.; Gao, S.; Günther, D.; Xu, J.; Gao, C.G.; Chen, H.H. In situ analysis of major and trace elements of anhydrous minerals by LA-ICP-MS without applying an internal standard. *Chem. Geol.* **2008**, *257*, 34–43. [\[CrossRef\]](#)
34. Ludwig, K.R. *User's Manual for Isoplot 3.00: A Geochronological Toolkit for Excel*; Berkeley Geochronology Center Special Publication: Berkeley, CA, USA, 2003; Volume 4, 67p.
35. Black, L.P.; Kamo, S.L.; Allen, C.M.; Aleinikoff, J.N.; Davis, D.W.; Korsch, R.J.; Foudoulis, C. TEMORA 1: A new zircon standard for U-Pb geochronology. *Chem. Geol.* **2003**, *200*, 155–170. [\[CrossRef\]](#)
36. He, Z.Y.; Klemm, R.; Zhang, Z.M.; Zong, K.Q.; Sun, L.X.; Tian, Z.L.; Huang, B.T. Mesoproterozoic continental arc magmatism and crustal growth in the eastern Central Tianshan Arc Terrane of the southern Central Asian Orogenic Belt: Geochronological and geochemical evidence. *Lithos* **2015**, *236–237*, 74–89. [\[CrossRef\]](#)
37. Jochum, K.P.; Weis, U.; Stoll, B.; Kuzmin, D.; Yang, Q.; Raczek, I.; Jacob, D.E.; Stracke, A.; Birbaum, K.; Frick, D.A.; et al. Determination of reference values for NIST SRM 610–617 glasses following ISO guidelines. *Geostand. Geoanal. Res.* **2011**, *35*, 397–429. [\[CrossRef\]](#)
38. Yuan, H.L.; Gao, S.; Liu, X.M.; Li, H.M.; Günther, D.; Wu, F.Y. Accurate U-Pb Age and Trace Element Determinations of Zircon by Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry. *Geostand. Geoanal. Res.* **2004**, *11*, 353–370. [\[CrossRef\]](#)
39. Hu, Z.C.; Liu, Y.S.; Gao, S.; Liu, W.G.; Zhang, W.; Tong, X.R.; Lin, L.; Zong, K.Q.; Li, M.; Chen, H.H. Improved in situ Hf isotope ratio analysis of zircon using newly designed X skimmer cone and jet sample cone in combination with the addition of nitrogen by laser ablation multiple collector ICP-MS. *J. Anal. At. Spectrom.* **2012**, *27*, 1391–1399. [\[CrossRef\]](#)
40. Liu, Y.S.; Gao, S.; Hu, Z.C.; Gao, C.G.; Zong, K.Q.; Wang, D.B. Continental and Oceanic Crust Recycling-induced Melt-peridotite Interactions in the Trans-north China Orogen: U-Pb dating, Hf isotopes and trace elements in Zircons from Mantle Xenoliths. *J. Pet. Sci. Eng.* **2010**, *51*, 537–571. [\[CrossRef\]](#)
41. Patchett, J.; Kouvo, O. Origin of continental crust of 1.9–1.7 Ga age: Nd isotopes and U-Pb zircon ages in the Svecokarelian terrain of South Finland. *Contrib. Min. Pet.* **1986**, *92*, 1–12. [\[CrossRef\]](#)
42. Segal, I.; Halica, L.; Platzner, I.T. Accurate isotope ratio measurements of ytterbium by multiple collection inductively coupled plasma mass spectrometry applying erbium and hafnium in an improved double external normalization procedure. *J. Anal. At. Spectrom.* **2003**, *18*, 1217–1223. [\[CrossRef\]](#)
43. Fisher, C.M.; Vervoort, J.D.; Hanchar, J.M. Guidelines for reporting zircon Hf isotopic data by LA-MC-ICPMS and potential pitfalls in the interpretation of these data. *Chem. Geol.* **2014**, *363*, 125–133. [\[CrossRef\]](#)
44. Blichert-Toft, J.; Albarède, F. The Lu-Hf isotope geochemistry of chondrites and the evolution of the mantle-crust system. *Earth Planet. Sci. Lett.* **1997**, *148*, 243–258. [\[CrossRef\]](#)
45. Blichert-Toft, J. The Hf isotopic composition of zircon reference material 91500. *Chem. Geol.* **2008**, *253*, 252–257. [\[CrossRef\]](#)
46. Söderlund, U.; Patchett, P.J.; Vervoort, J.D.; Isachsen, C.E. The ^{176}Lu decay constant determined by Lu-Hf and U-Pb isotope systematics of Precambrian mafic intrusions. *Earth Planet. Sci. Lett.* **2004**, *219*, 311–324. [\[CrossRef\]](#)
47. Griffin, W.L.; Pearson, N.J.; Belousova, E.; Jackson, S.E.; Van Acherterbergh, E.; O'Reilly, S.Y.; Shee, S.R. The Hf isotope composition of cratonic mantle: LAM-MC-ICPMS analysis of zircon megacrysts in kimberlites. *Geochim. Cosmochim. Acta* **2000**, *64*, 133–147. [\[CrossRef\]](#)
48. Griffin, W.L.; Wang, X.; Jackson, S.E.; Pearson, N.J.; O'Reilly, S.Y.; Xu, X.; Zhou, X. Zircon chemistry and magma mixing, SE China: In-situ analysis of Hf isotopes, Tonglu and Pingtan igneous complexes. *Lithos* **2002**, *61*, 237–269. [\[CrossRef\]](#)
49. Kong, L.Y.; Mao, X.W.; Chen, C.; Deng, Q.Z.; Zhang, H.J.; Yang, Q.X.; Li, L.J.; Li, Q.W. Chronological study on detrital zircons and its geological significance from Mesoproterozoic Dagushi Group in the Dahongshan Area, north margin of the Yangtze Block. *Earth Sci.* **2017**, *42*, 485–501.
50. Chen, K.; Gao, S.; Wu, Y.B.; Guo, J.L.; Hu, Z.C.; Liu, Y.S.; Zong, K.Q.; Liang, Z.W.; Geng, X.L. 2.6–2.7 Ga crustal growth in Yangtze craton, South China. *Precambrian Res.* **2013**, *224*, 472–490. [\[CrossRef\]](#)

51. Guo, J.L.; Wu, Y.B.; Gao, S.; Jin, Z.M.; Zong, K.Q.; Hu, Z.C.; Chen, K.; Chen, H.H.; Liu, Y.S. Episodic Paleoarchean–Paleoproterozoic (3.3–2.0 Ga) granitoid magmatism in Yangtze Craton, South China: Implications for late Archean tectonics. *Precambrian Res.* **2015**, *270*, 246–266. [\[CrossRef\]](#)
52. Wang, Z.J.; Wang, J.; Du, Q.D.; Deng, Q.; Yang, F. The evolution of the Central Yangtze Block during early Neoproterozoic time: Evidence from geochronology and geochemistry. *J. Asian Earth Sci.* **2013**, *77*, 31–44. [\[CrossRef\]](#)
53. Zhou, G.Y.; Wu, Y.B.; Gao, S.; Yang, J.Z.; Zheng, J.P.; Qin, Z.W.; Wang, H.; Yang, S.H. The 2.65 Ga A-type granite in the northeastern Yangtze craton: Petrogenesis and geological implications. *Precambrian Res.* **2015**, *258*, 247–259. [\[CrossRef\]](#)
54. Qiu, Y.M.; Gao, S.; McNaughton, N.J.; Groves, D.I.; Ling, W.L. First evidence of >3.2 Ga continental crust in the Yangtze craton of south China and its implications for Archean crustal evolution and Phanerozoic tectonics. *Geology* **2000**, *28*, 11–14. [\[CrossRef\]](#)
55. Zhang, S.B.; Zheng, Y.F.; Wu, Y.B.; Zhao, Z.F.; Gao, S.; Wu, F.Y. Zircon isotope evidence for ≥ 3.5 Ga continental crust in the Yangtze craton of China. *Precambrian Res.* **2006**, *146*, 16–34. [\[CrossRef\]](#)
56. Jiao, W.F.; Wu, Y.B.; Yang, S.H.; Peng, M.; Wang, J. The oldest basement rock in the Yangtze Craton revealed by zircon U–Pb age and Hf isotope composition. *Sci. China Ser. D Earth Sci.* **2009**, *52*, 1393–1399. [\[CrossRef\]](#)
57. Gao, S.; Yang, J.; Zhou, L.; Li, M.; Hu, Z.C.; Guo, J.L.; Yuan, H.L.; Gong, H.J.; Xiao, G.Q.; Wei, J.Q. Age and growth of the Archean Kongling terrain, South China, with emphasis on 3.3 Ga granitoid gneisses. *Am. J. Sci.* **2011**, *311*, 153–182. [\[CrossRef\]](#)
58. Guo, J.L.; Gao, S.; Wu, Y.B.; Li, M.; Chen, K.; Hu, Z.C.; Liang, Z.W.; Liu, Y.S.; Zhou, L.; Zong, K.Q. 3.45 Ga granitic gneisses from the Yangtze Craton, South China: Implications for Early Archean crustal growth. *Precambrian Res.* **2014**, *242*, 82–95. [\[CrossRef\]](#)
59. Zhang, S.B.; Zheng, Y.F.; Wu, Y.B.; Zhao, Z.F.; Gao, S.; Wu, F.Y. Zircon U–Pb age and Hf–O isotope evidence for Paleoproterozoic metamorphic event in South China. *Precambrian Res.* **2006**, *151*, 265–288. [\[CrossRef\]](#)
60. Xiong, Q.; Zheng, J.P.; Yu, C.M.; Su, Y.P.; Tang, H.Y.; Zhang, Z.H. Zircon U–Pb age and Hf isotope of Quanyishang A-type granite in Yichang: Signification for the Yangtze continental cratonization in Paleoproterozoic. *Chin. Sci. Bull.* **2009**, *54*, 436–446. [\[CrossRef\]](#)
61. Wang, Z.J.; Wang, J.; Deng, Q.; Du, Q.D.; Zhou, X.L.; Yang, F.; Liu, H. Paleoproterozoic I-type granites and their implications for the Yangtze block position in the Columbia supercontinent: Evidence from the Lengshui Complex, South China. *Precambrian Res.* **2015**, *263*, 157–173. [\[CrossRef\]](#)
62. Han, Q.S.; Peng, S.B.; Kusky, T.; Polat, A.; Jiang, X.F.; Cen, Y.; Liu, S.F.; Deng, H. A Paleoproterozoic ophiolitic mélange, Yangtze craton, South China: Evidence for Paleoproterozoic suturing and microcontinent amalgamation. *Precambrian Res.* **2017**, *293*, 13–38. [\[CrossRef\]](#)
63. Zhou, G.Y.; Wu, Y.B.; Wang, H.; Qin, Z.W.; Zhang, W.X.; Zheng, J.P.; Yang, S.H. Petrogenesis of the Huashanguan A-type granite complex and its implications for the early evolution of the Yangtze Block. *Precambrian Res.* **2017**, *292*, 57–74. [\[CrossRef\]](#)
64. Han, Q.S.; Peng, S.B.; Polat, A.; Kusky, T.; Deng, H.; Wu, T.Y. A ca. 2.1 Ga Andean-type margin built on metasomatized lithosphere in the northern Yangtze craton, China: Evidence from high-Mg basalts and andesites. *Precambrian Res.* **2018**, *309*, 309–324. [\[CrossRef\]](#)
65. Zheng, Y.F.; Zhao, Z.F.; Wu, Y.B.; Zhang, S.B.; Liu, X.M.; Wu, F.Y. Zircon U–Pb age, Hf and O isotope constraints on protolith origin of ultrahigh-pressure eclogite and gneiss in the Dabie orogen. *Chem. Geol.* **2006**, *231*, 135–158. [\[CrossRef\]](#)
66. Li, Y.H.; Zheng, J.P.; Xiong, Q.; Wang, W.; Ping, X.Q.; Li, X.Y.; Tang, H.Y. Petrogenesis and tectonic implications of Paleoproterozoic metapelitic rocks in the Archean Kongling Complex from the northern Yangtze Craton, South China. *Precambrian Res.* **2016**, *276*, 158–177. [\[CrossRef\]](#)
67. Geng, Y.S.; Liu, Y.Q.; Gao, L.Z.; Peng, N.; Jiang, X.J. Geochronology of the Mesoproterozoic Tong’an Formation in Southwestern Margin of Yangtze Craton: New Evidence from Zircon LA-ICP-MS U–Pb Ages. *Acta Geol. Sin.* **2012**, *86*, 1479–1490. (In Chinese with English abstract)
68. Li, H.K.; Zhang, C.L.; Yao, C.Y.; Xiang, Z.Q. U–Pb zircon age and Hf isotope compositions of Mesoproterozoic sedimentary strata on the western margin of the Yangtze massif. *Sci. China Earth Sci.* **2013**, *56*, 628–639. [\[CrossRef\]](#)
69. Pang, W.H.; Ren, G.M.; Sun, Z.M.; Yin, F.G. Division and correlation of Paleo–Mesoproterozoic strata on the western margin of Yangtze Block: Evidence from the U–Pb age of tuff zircon in the Tongan Formation. *Geol. China* **2015**, *42*, 921–936.
70. Cawood, P.A.; Wang, W.; Zhao, T.Y.; Xu, Y.J.; Mulder, J.A.; Pisarevsky, S.A.; Zhang, L.M.; Gan, C.S.; He, H.Y.; Liu, H.C.; et al. Deconstructing South China and consequences for reconstructing Nuna and Rodinia. *Earth Sci. Rev.* **2020**, *204*, 1–24. [\[CrossRef\]](#)
71. Liu, L.; Pan, L.K.; Du, Y.C.; Gong, Z.Y.; Luo, F. Geochemical characteristics and geological significance of Shicaohe volcanic rocks of Shennongjia Group in western Hubei Province. *Resour. Environ. Eng.* **2015**, *29*, 370–376.
72. Wang, N.S. *Sedimentary Facies of the Middle Part of Shennongjia Group—An Example from Shennongjia Section, Shennongjia Region*; Chinese Academy of Geological Science: Beijing, China, 2016.
73. Lu, S.N.; Chen, Z.H.; Xiang, Z.Q.; Li, H.K.; Li, H.M. U–Pb ages of detrital zircons from the para-metamorphic rocks of the Qinling Group and their geological significance. *Earth Sci. Front.* **2006**, *13*, 303–310.
74. Li, X.H.; Chen, F.K.; Guo, J.H.; Li, Q.L.; Xie, L.W.; Siebel, W. South China provenance of the lower-grade Penglai Group north of the Sulu UHP orogenic belt, eastern China: Evidence from detrital zircon ages and Nd–Hf isotopic composition. *Geochim. J.* **2007**, *41*, 29–45. [\[CrossRef\]](#)
75. Yang, L.; Chen, F.K.; Yang, Y.Z.; Li, S.Q.; Zhu, X.Y. Zircon U–Pb ages of the Qinling Group in Danfeng area: Recording Mesoproterozoic and Neoproterozoic magmatism and Early Paleozoic metamorphism in the North Qinling terrain. *Acta Petrol. Sin.* **2010**, *26*, 1589–1603, (In Chinese with English abstract).

76. Chu, H.; Lu, S.N.; Wang, H.C.; Xiang, Z.Q.; Liu, H. U-Pb age spectrum of detrital zircons from the Fuzikuang Formation, Penglai Group in Changdao, Shandong Province. *Acta Petrol. Sin.* **2011**, *27*, 1017–1028. (In Chinese with English abstract)
77. Diwu, C.; Sun, Y.; Zhang, H.; Wang, Q.; Guo, A.L.; Fan, L.G. Episodic tectonothermal events of the western North China Craton and North Qinling Orogenic Belt in central China: Constraints from detrital zircon U-Pb ages. *J. Asian Earth Sci.* **2012**, *47*, 107–122. [\[CrossRef\]](#)
78. Wang, W.; Zhou, M.F.; Yan, D.P.; Li, J.W. Depositional age, provenance, and tectonic setting of the Neoproterozoic Sibao Group, southeastern Yangtze Block, South China. *Precambrian Res.* **2012**, *192–195*, 107–124. [\[CrossRef\]](#)
79. Yang, C.; Li, X.H.; Wang, X.C.; Lan, Z.W. Mid-Neoproterozoic angular unconformity in the Yangtze Block revisited: Insights from detrital zircon U-Pb age and Hf-O isotopes. *Precambrian Res.* **2015**, *266*, 165–178. [\[CrossRef\]](#)
80. Ma, X.; Yang, K.G.; Li, X.G.; Dai, C.G.; Zhang, H.; Zhou, Q.; McFarlane, C. Neoproterozoic Jiangnan Orogeny in Southeast Guizhou, South China: Evidence from U-Pb ages for Detrital Zircons from the Sibao Group and Xiajiang Group. *Can. J. Earth Sci.* **2016**, *53*, 219–230. [\[CrossRef\]](#)
81. Wang, H.; Wu, Y.B.; Gao, S.; Liu, X.C.; Gong, H.J.; Li, Q.L.; Li, X.H.; Yuan, H.L. Eclogite origin and timings in the North Qinling terrane, and their bearing on the amalgamation of the South and North China Blocks. *J. Metamorph. Geol.* **2011**, *29*, 1019–1031. [\[CrossRef\]](#)
82. Wang, Z.Z.; Guo, Y.; Yang, B.; Wang, S.W.; Sun, X.M.; Hou, L.; Zhou, B.G.; Liao, Z.W. Discovery of the 1.73 Ga Haizi Anorogenic Type Granite in the Western Margin of Yangtze Craton, and Its Geological Significance. *Acta Geol. Sin.* **2013**, *87*, 931–942.
83. Wang, D.B.; Yin, F.G.; Sun, Z.M.; Wang, L.Q.; Wang, B.D.; Liao, S.Y.; Tang, Y.; Ren, G.M. Zircon U-Pb age and Hf isotope of Paleoproterozoic mafic intrusion on the western margin of the Yangtze Block and their implications. *Geol. Geol. Bull. China* **2013**, *32*, 617–630.
84. Wang, S.W.; Liao, Z.W.; Sun, X.M.; Jiang, X.F.; Zhou, B.G.; Guo, Y.; Luo, M.J.; Zhu, H.P.; Ma, D. Geochemistry of Paleoproterozoic Diabases in the Dongchuan Copper deposit, Yunnan, SW China: Response to Breakup of the Columbia Supercontinent in the Southwestern Margin of Yangtze Block. *Acta Geol. Sin.* **2013**, *87*, 1834–1852.
85. Yang, H.; Liu, P.H.; Meng, E.; Wang, F.; Xiao, L.L.; Liu, C.H. Geochemistry and its tectonic implications of metabasite in the Dahongshan Group in Southwestern Yangtze block. *Acta Petrol. Sin.* **2014**, *30*, 3021–3033.
86. Belousova, E.; Griffin, W.L.; O'Reilly, S.Y.; Fisher, N. Igneous zircon: Trace element composition as an indicator of source rock type. *Contrib. Min. Pet.* **2002**, *143*, 602–622. [\[CrossRef\]](#)
87. Maas, R.; Kinny, P.D.; Williams, I.S.; Froude, D.O.; Compston, W. The Earth's oldest known crust: A geochronological and geochemical study of 3900–4200 Ma old detrital zircons from Mt. Narryer and Jack Hills, Western Australia. *Geochim. Cosmochim. Acta* **1992**, *56*, 1281–1300. [\[CrossRef\]](#)
88. Carley, T.L.; Miller, C.F.; Wooden, J.L.; Padilla, A.J.; Schmitt, A.K.; Economos, R.C.; Bindeman, L.N.; Jordan, B.T. Iceland is not a magmatic analog for the Hadean: Evidence from the zircon record. *Earth Planet. Sci. Lett.* **2014**, *405*, 85–97. [\[CrossRef\]](#)
89. Grimes, C.B.; Wooden, J.L.; Cheadle, M.J.; John, B.E. “Fingerprinting” tectono-magmatic provenance using trace elements in igneous zircon. *Contrib. Min. Pet.* **2015**, *170*, 46. [\[CrossRef\]](#)
90. Hawkesworth, C.J.; Kemp, A.I.S. Using hafnium and oxygen isotopes in zircons to unravel the record of crustal evolution. *Chem. Geol.* **2006**, *226*, 144–162. [\[CrossRef\]](#)
91. Yang, J.H.; Cawood, P.A.; Du, Y.S.; Huang, H.; Huang, H.W.; Tao, P. Large Igneous Province and magmatic arc sourced Permian-Triassic volcanogenic sediments in China. *Sediment. Geol.* **2012**, *261–262*, 120–131. [\[CrossRef\]](#)
92. Zhao, J.H.; Zhou, M.F.; Wu, Y.B.; Zheng, J.P.; Wang, W. Coupled evolution of Neoproterozoic arc mafic magmatism and mantle wedge in the western margin of the South China Craton. *Contrib. Min. Pet.* **2019**, *174*, 1–36. [\[CrossRef\]](#)
93. Roberts, N.M.W.; Slagstad, T. Continental growth and reworking on the edge of the Columbia and Rodinia supercontinents: 1.86–0.9 Ga accretionary orogeny in southwest Fennoscandia. *Int. Geol. Rev.* **2015**, *57*, 1582–1606. [\[CrossRef\]](#)
94. Roy, A.; Sarkar, A.; Jeyakumar, S.; Aggrawal, S.K.; Ebihara, M. Mid-Proterozoic plume related thermal event in eastern Indian craton: Evidence from trace elements, REE geochemistry and Sr-Nd isotope systematics of basic-ultrabasic intrusives from Dalma volcanic belt. *Gondwana Res.* **2002**, *5*, 133–146. [\[CrossRef\]](#)
95. Teixeira, W.; DAgrella-Filho, M.S.; Ernst, R.E.; Hamilton, M.A.; Girardi, V.A.V.; Mazzucchelli, M.; Bettencourt, J.S. U-Pb (ID-TIMS) baddeleyite ages and paleomagnetism of 1.79 and 1.59 Ga tholeiitic dyke swarms, and position of the Rio de la Plata Craton within the Columbia supercontinent. *Lithos* **2013**, *174*, 157–174. [\[CrossRef\]](#)
96. Silveira, E.M.; Söderlund, U.; Oliveira, E.P.; Ernst, R.E.; Menezes Leal, A.B. First precise U-Pb baddeleyite ages of 1500 Ma mafic dykes from the São Francisco Craton, Brazil, and tectonic implications. *Lithos* **2013**, *174*, 144–156. [\[CrossRef\]](#)
97. Rao, C.V.D.; Santosh, M. Continental arc magmatism in a Mesoproterozoic convergent margin: Petrological and geochemical constraints from the magmatic suite of Kondapalle along the eastern margin of the Indian plate. *Tectonophysics* **2011**, *510*, 151–171. [\[CrossRef\]](#)
98. Rao, C.V.D.; Santosh, M.; Zhang, Z.M.; Tsunogae, T. Mesoproterozoic arc magmatism in SE India: Petrology, zircon U-Pb geochronology and Hf isotopes of the Bopudi felsic suite from Eastern Ghats Belt. *J. Asian Earth Sci.* **2013**, *75*, 183–201.
99. Subramanyam, K.S.V.; Santosh, M.; Yang, Q.Y.; Zhang, Z.M.; Balaram, V.; Reddy, U.V.B. Mesoproterozoic island arc magmatism along the south-eastern margin of the Indian Plate: Evidence from geochemistry and zircon U-Pb ages of mafic plutonic complexes. *J. Asian Earth Sci.* **2016**, *30*, 116–138. [\[CrossRef\]](#)

-
100. Furlanetto, F.; Thorkelson, D.J.; Rainbird, R.H.; Davis, W.J.; Gibson, H.D.; Marshall, D.D. The Paleoproterozoic Wernecke Supergroup of Yukon, Canada: Relationships to orogeny in northwestern Laurentia and basins in North America, East Australia, and China. *Gondwana Res.* **2016**, *39*, 14–40. [[CrossRef](#)]
 101. Morel, M.L.A.; Nebel, O.; Nebel-Jacobsen, Y.J.; Miller, J.S.; Vroon, P.Z. Hafnium isotope characterization of the GJ-1 zircon reference material by solution and laser-ablation MC-ICPMS. *Chem. Geol.* **2008**, *255*, 231–235. [[CrossRef](#)]