Supplementary Materials for

Seismological evidence for the earliest global subduction network at 2 Ga ago

Bo Wan*, Xusong Yang, Xiaobo Tian*, Huaiyu Yuan, Uwe Kirscher, Ross N. Mitchell*

*Corresponding author. Email: wanbo@mail.iggcas.ac.cn (B.W.); txb@mail.iggcas.ac.cn (X.T.); ross.mitchell@mail.iggcas.ac.cn (R.N.M.)

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This PDF file includes:

Sections S1 and S2
Figs. S1 to S7
Table S1
References
Supplementary Text

Section 1. Orosirian Orogenes

Widespread orogenesis of the Orosirian Period has been thoroughly reviewed by previous researchers (5, 33). Recent discoveries include mounting evidence for high-pressure/low-temperature (HP/LP) rocks (8, 9, 59). The polarities of those orogens of Laurentia without seismic constraints have been argued for geologically (60) and are depicted with slight transparency in Figure 5. Here we briefly provide more information on those HP/LP orogenic belts and note the availability of seismic profiles.

**Trans-Hudson Orogen of Laurentia.** The Trans-Hudson Orogen consists of four principal tectonic domains: the Thompson belt, the Reindeer zone, the Watham-Chipeyan batholith, and the Cree Lake zone (61). The Ungava Orogen of northern Quebec is interpreted as the continuation of the Trans-Hudson Orogen. Ref. (8) reported a HP/LP eclogite (2.50 ± 0.15 GPa, 735 ± 35°C) from 1.8 Ga in the Cape Smith thrust belt. In the adjacent region, a 2.0-Ga Purtuniqui ophiolite is also reported (38).

**Wopmay Orogen of Laurentia.** The Wopmay Orogen in the Northwest Territories of Canada was a short-lived collisional belt that developed between the Archean Slave craton and the Hottah Terrane between ~1.9 and 1.84 Ga. Seismic reflection and receiver function (RF) results indicate that Hottah Terrane underthrusts Slave craton (62).

**The Nagssugtoqidian Orogen of Laurentia.** The Nagssugtoqidian Orogen is an east-west trending orogen located in southeast Greenland. It is a 1.87-1.84 Ga collisional orogen that separates Archean cratons to the north and south. A 1.87 Ga eclogite (1.7-1.9 GPa, 740–810°C) has been reported in the orogen (63, 64).

**Svecofennian Orogen of Baltica.** The Svecofennian Orogen is an east-west striking belt in northern Baltica. One of the best-preserved Paleoproterozoic ophiolites, the 1.95 Ga Jormua ophiolite outcrops along the orogen in Finland (37). The 1.9 Ga Belomorian eclogite (1.8 GPa, 695–755°C) was also reported along the belt in Russia (65).

**Yenisey belt of Siberia.** The Yenisey belt is located along the southwestern margin of Siberia. A series of rock occurrences including an ultramafic complex, amphibolite, granulite, metacarbonate, and metapelitic in the Sharyzhalgai region is comparable to modern ophiolite sequences and has been interpreted as a Paleoproterozoic ophiolite (66).

**Trans-North China Orogen of North China.** The western North China block collided with the eastern North China block at ~1.85-1.80 Ga (5). RF studies indicate that the eastern block underthrusts the western block (67).

Section 2. Additional paleogeography considerations.

The precise position of Siberia in Nuna is much debated with models ranging between a tight fit or loose fit with respect to northern Laurentia. Both tight (33) and a loose fits (68) have been argued for on the basis of paleomagnetism. Recently, it has also been proposed that the Yangtze block of South China may fit in between Laurentia and Siberia in the loose-fit configuration (69). Given the ambiguity of paleomagnetic interpretations of the Siberia data at the moment, we opt for the tight-fit configuration due to the additional support from matching coeval large igneous provinces (55). We do note however, that our interpretation of widespread subduction-driven convergence during Nuna assembly is not dependent on this particular aspect of the reconstruction selected. In fact, the addition of the Yangtze block in between Laurentia and Siberia (69) would actually increase the widespread nature of the subduction-driven convergence of core constituents of Nuna. Future work including acquiring additional paleomagnetic poles can aim to resolve such reconstruction options.
**Fig. S1. Example seismic event.** Amplitude spectrum of raw seismic data from an event and its corresponding instrument response removed data. (A) Seismogram. (B) Spectrogram.
Fig. S2. Receiver Function (RF) time-domain records. (A-B) Two earthquakes from southwest (piercing points marked in Figure 1B by red crosses). (C-D) Earthquakes from southeast (blue crosses). Average RF is shown on right, where the direct P and the averaged Moho arrivals can be clearly seen at 0 and ~6 s, respectively. Vertical black dashed lines show the location of Station 1008 and 1089 used for tests in figure S5.
Fig. S3. Common Conversion Point (CCP) depth section computed from different $V_p/V_s$ ratios. The distance between -14 and 156 km was stacked by only three coherent teleseismic events from the southwest, and the distance between 156 and 310 km was stacked by all the 16 teleseismic events. (A) The $V_p/V_s$ ratio was fixed to 2.0, where $V_p$ is < 5.8 km s$^{-1}$ (sedimentary layer) and varied for the basement ($V_p$ > 5.8 km s$^{-1}$). In this case $V_p/V_s$ is 1.7. (B) Same as A, but $V_p/V_s$ is set to 1.73 for the basement. (C) Same as A, but $V_p/V_s$ is set to 1.8 for the basement. (D) Moho depths picked for different $V_p/V_s$ ratios, respectively.
Fig. S4. Common conversion point (CCP) depth section computed for events with different ranges of back-azimuths. (A) Topography along seismic profile. (B) CCP using all back-azimuths except no events from the northwest. (C) CCP using only back-azimuths from the southwest. Amplitude scale indicated by color scale in (C) is the same for the 2 sections.
Fig. S5. Dipping Moho and receiver function (RF) back-azimuthal variations. (A) Synthetic radial (left) and tangential receiver functions (right) computed for station 1008 using the model in Figure 3 and a 0.065 s km\(^{-1}\) slowness for all back-azimuths. (B) Synthetic RFs computed using the real data slowness and back-azimuth, and then averaged into 10° back-azimuth bins. (C) Real data plotted the same way as in B. Features other than the Moho are masked for simplicity. (D-F) Same as A-C, but for station 1089. Location of stations are marked in figure S2.
Fig. S6. A synthetic test to identity the origin of shallow structure. (A) Three continuous positive phases on the receiver function (RF) section. (B-C) Velocity models (left) and corresponding synthetic (right). RF without multiples (black line), RF with multiples (blue dash line), and RF with multiples but without Moho conversion (red dash line).
Fig. S7. Modern Himalayan Orogen and Orosirian Khondalite Orogen. A comparison of surface tectonics (left) and deep seismic structures (right) between modern northern India (top) and Orosirian northern North China (bottom). Modern Himalayan range and its receiver function (RF) image across the thrust belt and suture from 0-350 km along the profile of ref. (10). Tectonic map of western North China is from ref. (5). The deep RF image is at 0-300 km distance along the array of this study in figure S4C. The Moho dipping and deepening of the Himalayan thrust is comparable with that of the Khondalite thrust of North China. Further north, however, this part of North China has been reworked by later tectonic events. The mismatch between the two Mohos in the northern portion is either because the reworked part of the Orosirian Moho has detached some of its crust to shallow its Moho, and/or the modern Himalaya is overthickened and has not evolved yet to losing the lower part of its crust to stabilize.
Table S1. Teleseismic events used in this study

| time         | latitude | longitude | depth | mag | gcarc  | baz   |
|--------------|----------|-----------|-------|-----|--------|-------|
| 2019-04-22T09:11:12.013Z | 14.9538  | 120.5149  | 21.84 | 6.1 | 26.4154 | 157.037 |
| 2019-04-23T05:37:53.147Z | 11.759   | 125.2293  | 56    | 6.4 | 31.0168 | 150.411 |
| 2019-04-23T20:15:50.804Z | 28.414   | 94.5988   | 14    | 5.9 | 17.1671 | 233.3   |
| 2019-04-29T14:19:52.499Z | 10.8649  | 57.2283   | 10    | 6.3 | 54.8638 | 253.393 |
| 2019-05-03T07:25:29.171Z | -6.928   | 160.1389  | 10    | 6.2 | 65.5701 | 123.394 |
| 2019-05-04T01:05:09.527Z | 12.3713   | 120.9321  | 10    | 5.7 | 28.9993 | 157.891 |
| 2019-05-04T21:02:10.594Z | 1.9846   | 123.6614  | 327   | 5.7 | 39.725 | 158.596 |
| 2019-05-06T21:19:37.983Z | -6.9752  | 146.4486  | 146   | 7.1 | 57.4973 | 135.852 |
| 2019-05-14T12:58:26.074Z | -4.081   | 152.5694  | 10    | 7.5 | 58.6268 | 128.017 |
| 2019-05-16T01:23:59.424Z | -5.2257  | 152.6189  | 25.33 | 5.7 | 59.5686 | 128.778 |
| 2019-05-17T22:37:47.788Z | -4.5834  | 153.0098  | 21    | 5.9 | 59.2926 | 127.966 |
| 2019-05-18T01:51:30.078Z | -9.4947  | 108.6653  | 10    | 5.6 | 49.2824 | 181.953 |
| 2019-05-19T01:23:29.130Z | -21.6713 | 169.8042  | 20    | 6.3 | 82.8291 | 126.081 |
| 2019-05-19T14:56:50.691Z | -21.6074 | 169.4692  | 20    | 6.3 | 82.7363 | 126.286 |
| 2019-05-22T00:39:34.963Z | 13.8921  | 92.9916   | 29    | 5.6 | 29.9488 | 215.041 |
| 2019-05-23T08:45:18.547Z | 51.3631  | -178.3306 | 27.79 | 6.1 | 49.3135 | 51.341 |

Notes: gcarc and baz are mean values of the great circle distance and back-azimuth in degrees, respectively.
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