Appendix 1*

Summary of whole-rock Sm–Nd data for samples from the Pilbara Craton

Appendix 2

Zircon Hf isotope data from Mount Edgar samples

Appendix 3

Zircon Hf isotope standard data

* Appendices 1–3 are provided as compressed digital files (Excel spreadsheets) to accompany the PDF available online at <www.dmp.wa.gov.au/GSWApublications>.

Appendix 4

Lu–Hf isotope analytical methods

Hafnium isotope analyses were conducted on previously dated zircons using a New Wave/Merchantek LUV213 laser-ablation microprobe, attached to a Nu Plasma multi-collector inductively coupled plasma mass spectrometer (LA-MC-ICP-MS) at Macquarie University. The method has been discussed in detail elsewhere (Griffin et al., 2000). Analyses involved a laser beam diameter of ~40 µm with ablation pits 40–60 µm deep. The ablated sample material was transported from the laser cell to the ICP-MS torch in a helium gas flow. Interference of ^{176}Lu on ^{176}Hf was corrected by measurement of the interference-free ^{175}Lu and using an invariant ^{176}Lu/^{175}Lu correction factor. Isobaric interference of ^{176}Yb on ^{176}Hf was corrected by measurement of the interference-free ^{172}Yb isotope and using the ^{176}Yb/^{172}Yb ratio to calculate the intensity of interference free ^{176}Yb. The appropriate value of ^{176}Yb/^{172}Yb was determined by successive doping of the JMC475 Hf standard with various amounts of Yb.

Analyses of samples in the Pilbara dataset were conducted over five sessions. Zircons from the Mudtank carbonatite locality were analysed, together with the samples, as a measure of the accuracy of the results. Most of the data and the mean ^{176}Hf/^{177}Hf value of Mudtank zircon in each session (session 1: 0.282525 ± 18, n = 50; session 2: 0.282542 ± 28, n = 19; session 3; 0.282523 ± 15, n = 17; session 4; 0.282522 ± 31, n = 39; session 5; 0.282539 ± 52, n = 76) are within 2 standard deviations (SD) of the recommended value (0.282522 ± 42 (2σ) (Griffin et al., 2007). Temora-2 zircon was run as an independent check on the accuracy of the Yb correction. Temora zircon has an average ^{176}Yb/^{177}Hf ratio of 0.04, which is similar to the mean ^{176}Yb/^{177}Hf ratio of zircon in this study (0.03). The average ^{176}Hf/^{177}Hf ratio for Temora-2 in each session (session 1: 0.282681 ± 20, n = 6; session 2: 0.282695 ± 28, n = 4; session 3: 0.282683 ± 26, n = 11; session 4: 0.282696 ± 27, n = 14; session 5: 0.282703 ± 31 n = 33) was consistent with the published value for the Temora-2 standard (0.282687 ± 24, LA-ICP-MS; Hawkesworth and Kemp [2006]). Calculation of ε_{Hf} values employs the decay constant of Scherer et al. (2001) and the CHUR values of Blichert-Toft and Albarède (1997).

Appendix 5

Phase equilibria modelling and phase model calculation

Pseudosections were calculated from the bulk composition of: 1) weighted mean of 10 least-altered C-F2 samples (Smithies et al., 2009); and 2) the 30% melt product of melting C-F2 along a geotherm of 900°C/GPa. Input bulk compositions (in mol%) are given in Table 5.1. Phase equilibria modelling was undertaken in the 10-component NCKFMASHTO chemical system in terms of the oxides Na_2O–CaO–K_2O–FeO–MgO–Al_2O_3–SiO_2–H_2O–TiO_2–O. Calculations used THERMOCALC version 3.45i (Powell and Holland, 1998) and the internally consistent thermodynamic dataset ds63 (updated 5 January 2015) (Holland and Powell, 2011). Activity–composition solution models were as follows: tonalitic melt, augite, hornblende (Green et al., 2016) with a reduced DQF value for the glaucophane end-member of –3 kJ/mol from 0 kJ/mol garnet, orthopyroxene, biotite, chlorite (White et al., 2014), olivine, epidote (Holland and Powell, 2011), magnetite–spinel (White et al., 2002), ilmenite– hematite (White et al., 2000), C$^-$1 plagioclase, K-feldspar (Holland and Powell, 2003), and muscovite–paragonite with a reduced DQF value for the margarite end-member of 5 kJ/mol from 6.5 kJ/mol. Pure phases include quartz, rutile, titanite, and aqueous fluid (H_2O). The H_2O content in the modelled composition was fixed to be just sufficient to saturate the solidus at 1.0 GPa (producing <1 mol% H_2O-saturated melt). For the average C-F2 composition, the quantity of H_2O-saturated melt is <5 mol% at all modelled pressures in excess of 0.4 GPa, but >5 mol% at pressures below this. For the 30% melt of C-F2, the volume of wet melting is <<5 mol% at all pressures. Calculations assume $Fe^{3+}/\Sigma Fe = 0.1$.

Table 5.2 shows the results of modelling of both C-F2 and TTG1: the abundance of phases as a function of melt fraction (all as mol% on a one oxide basis to approximate volume % [vol%]); calculated bulk Lu and Hf partition coefficient (*D*); calculated elemental Lu and Hf concentrations; and bulk $^{176}Lu/^{177}Hf$ ratios.

Table 5.1. Input bulk compositions used for phase equilibria modelling (mol%)

mol%	*Na_2O*	*CaO*	*K_2O*	*FeO*	*MgO*	*Al_2O_3*	*SiO_2*	*H_2O*	*TiO_2*	*O*
C-F2	2.954	8.560	0.360	11.486	6.221	8.910	54.929	4.734	1.269	0.578
TTG1	5.272	2.439	1.553	4.055	1.307	9.066	74.00	2.00	0.100	0.202

Table 5.2. Partition coefficients used for modelling. Abbreviations: aug, augite; opx, orthopyroxene; pl, plagioclase; ksp, K-feldspar; hb, hornblende; bi, biotite; g, garnet; ilm, ilmenite; zrc, zircon

Phase	*aug[a]*	*opx[b]*	*pl[a]*	*ksp[c]*	*hb[d]*	*bi[e]*	*g[a]*	*ilm[f]*	*zrc[g]*
Hf	0.233	0.06	0.01	0.012	0.38	2.1	0.23	0.38	971
Lu	0.28	0.22	0.025	0.034	0.51	0.743	5.5	0.084	689

Data sources: (a) McKenzie and O'Nions (1991); (b) Green et al. (2000); (c) Leeman and Phelps (1981); (d) Luhr and Carmichael (1980); (e) Matsui et al. (1977); (f) Zack and Brumm (1998); (g) Fujimaki (1986)

Appendix 6

Lu/Hf ratio calculation

A small amount of zircon (0.01 vol%) was added to each modelled phase assemblage, on the basis of petrographic observations, and the volume modes of mineral phases within the residuum normalized to 100% (phase modes in Table 6.1). To estimate the elemental concentrations of Lu and Hf in these melt products, we calculated a bulk partition coefficient (*D*) for both Lu and Hf from compiled phase-level distribution coefficients relevant to the C-F2 basaltic source considered here (Table 5.2), using equation 1 (example for Hf) for *n* phases, where *X* is the mole fraction of phase *k*:

$$D_{bulk}^{Hf} = \sum_{k=0}^{n} D_k^{Hf} . X_k \qquad \text{(Eq. 1)}$$

The elemental Lu and Hf concentration (*x*) was then calculated using equation 2, where *F* is melt fraction and $x^{initial}$ is the concentration of the trace element in the parent, in this example Hf:

$$x_{Hf} = \frac{x_{Hf}^{initial}}{D_{bulk}^{Hf} + \left(F * \left(1 - D_{bulk}^{Hf}\right)\right)} \qquad \text{(Eq. 2)}$$

The calculated elemental Lu/Hf ratios in each melt product were then converted to isotopic ratios. The $^{176}Lu/^{177}Hf$ ratio can be calculated from whole-rock compositional data based on the atomic abundances and weights of the isotopes ^{176}Lu and ^{177}Hf (equation 3). This defines a 'factor' that, when multiplied by the elemental Lu/Hf ratio, can be used to derive the isotopic ratio (equation 4).

$$Factor = \frac{At.ab.^{176}Lu \times At.wt.^{177}Hf}{At.ab.^{177}Hf \times At.wt.^{176}Lu} \qquad \text{(Eq. 3)}$$

$$Factor\ x\ \frac{Lu\ ppm}{Hf\ ppm} = {}^{176}\mathrm{Lu}/{}^{177}\mathrm{Hf} \qquad \text{(Eq. 4)}$$

Table 6.1 shows results from melt modelling of C-F2 and TTG1 and Table 6.2 the results from independently varying the mode of each phase in turn, taking 30% melt of C-F2 as a starting composition.

Table 6.1. Phase modes, bulk partition coefficient (D) and $^{176}Lu/^{177}Hf$ calculation results as a function of melt fraction modelling of: a) C-F2; b) 30% TTG1

Melt fraction	*aug*	*opx*	*pl*	*ksp*	*hb*	*bi*	*g*	*ilm*	*zcn*	D^{bulk} *Hf*	D^{bulk} *Lu*	*Hf (ppm)*	*Lu (ppm)*	*Lu/Hf*	$^{176}Lu/^{177}Hf$
Melting C-F2															
0.050	0.035	0.000	0.273	0.000	0.660	0.012	0.004	0.015	0.001	1.503	1.245	3.200	0.462	0.144	0.0202
0.101	0.083	0.000	0.290	0.000	0.506	0.000	0.101	0.018	0.001	1.490	1.731	3.284	0.344	0.105	0.0147
0.150	0.138	0.000	0.306	0.000	0.347	0.000	0.185	0.022	0.001	1.506	2.159	3.308	0.287	0.087	0.0122
0.200	0.190	0.000	0.320	0.000	0.202	0.000	0.260	0.027	0.001	1.532	2.546	3.318	0.255	0.077	0.0108
0.300	0.268	0.000	0.336	0.000	0.000	0.000	0.359	0.036	0.002	1.633	3.105	3.278	0.230	0.070	0.0098
0.400	0.286	0.000	0.334	0.000	0.000	0.000	0.337	0.042	0.002	1.850	3.142	3.134	0.250	0.080	0.0112
Melting 30% TTG1															
0.050	0.010	0.000	0.764	0.031	0.000	0.152	0.042	0.000	0.001	1.788	1.394	1.875	0.168	0.089	0.0125
0.101	0.022	0.000	0.742	0.053	0.000	0.078	0.104	0.000	0.002	1.705	1.724	2.006	0.140	0.070	0.0097
0.150	0.023	0.004	0.757	0.102	0.000	0.000	0.110	0.004	0.002	1.657	1.780	2.103	0.138	0.066	0.0092
0.200	0.019	0.004	0.838	0.037	0.000	0.000	0.096	0.004	0.002	1.760	1.780	2.038	0.142	0.070	0.0097
0.301	0.007	0.007	0.925	0.000	0.000	0.000	0.052	0.007	0.002	2.019	1.727	1.914	0.153	0.080	0.0112

Table 6.2. Modelling the independent variation of phases; assuming 30% melt fraction. Totals are normalized to 100% for calculation of overall bulk partition coefficient (*D*)

aug	*opx*	*pl*	*ksp*	*hbl*	*bi*	*g*	*ilm*	*zrc*	*Total*	D^{bulk}_{Hf}	D^{bulk}_{Lu}	*Hf (ppm)*	*Lu (ppm)*	*Lu/Hf*	$^{176}Lu/^{177}Hf$
0.177	0.000	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.660	1.633	3.105	3.28	0.23	0.070	0.0098
0.000	0.000	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.483	2.144	4.138	2.63	0.18	0.068	0.0095
0.050	0.000	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.533	1.965	3.777	2.82	0.19	0.069	0.0096
0.100	0.000	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.583	1.817	3.477	3.01	0.21	0.069	0.0097
0.150	0.000	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.633	1.692	3.225	3.19	0.22	0.070	0.0098
0.200	0.000	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.683	1.585	3.009	3.36	0.24	0.071	0.0099
0.250	0.000	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.733	1.493	2.823	3.52	0.25	0.071	0.0100
0.300	0.000	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.783	1.413	2.661	3.67	0.26	0.072	0.0101
0.350	0.000	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.833	1.342	2.518	3.82	0.28	0.072	0.0101
0.400	0.000	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.883	1.279	2.391	3.96	0.29	0.073	0.0102
0.450	0.000	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.933	1.223	2.278	4.09	0.30	0.074	0.0103
0.500	0.000	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.983	1.173	2.177	4.22	0.31	0.074	0.0104
0.177	0.000	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.660	1.633	3.105	3.28	0.23	0.070	0.0098
0.177	0.050	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.710	1.522	2.902	3.46	0.24	0.071	0.0099
0.177	0.100	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.760	1.426	2.726	3.64	0.26	0.071	0.0099
0.177	0.150	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.810	1.342	2.571	3.82	0.27	0.071	0.0100
0.177	0.200	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.860	1.267	2.434	3.99	0.28	0.071	0.0100
0.177	0.250	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.910	1.201	2.313	4.15	0.30	0.072	0.0100
0.177	0.300	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.960	1.141	2.204	4.30	0.31	0.072	0.0101
0.177	0.350	0.222	0.000	0.000	0.000	0.237	0.024	0.001	1.010	1.088	2.106	4.46	0.32	0.072	0.0101
0.177	0.400	0.222	0.000	0.000	0.000	0.237	0.024	0.001	1.060	1.039	2.017	4.60	0.33	0.072	0.0101
0.177	0.450	0.222	0.000	0.000	0.000	0.237	0.024	0.001	1.110	0.995	1.936	4.75	0.34	0.073	0.0102
0.177	0.500	0.222	0.000	0.000	0.000	0.237	0.024	0.001	1.160	0.955	1.862	4.88	0.36	0.073	0.0102
0.177	0.000	0.000	0.000	0.000	0.000	0.237	0.024	0.001	0.439	2.453	4.662	2.35	0.16	0.068	0.0096
0.177	0.000	0.025	0.000	0.000	0.000	0.237	0.024	0.001	0.464	2.321	4.412	2.46	0.17	0.068	0.0096
0.177	0.000	0.050	0.000	0.000	0.000	0.237	0.024	0.001	0.489	2.203	4.187	2.57	0.18	0.069	0.0096
0.177	0.000	0.100	0.000	0.000	0.000	0.237	0.024	0.001	0.539	1.999	3.801	2.78	0.19	0.069	0.0097
0.177	0.000	0.150	0.000	0.000	0.000	0.237	0.024	0.001	0.589	1.830	3.480	2.99	0.21	0.070	0.0098
0.177	0.000	0.200	0.000	0.000	0.000	0.237	0.024	0.001	0.639	1.688	3.210	3.19	0.22	0.070	0.0098
0.177	0.000	0.250	0.000	0.000	0.000	0.237	0.024	0.001	0.689	1.566	2.978	3.39	0.24	0.071	0.0099

Table 6.2. continued

aug	*opx*	*pl*	*ksp*	*hbl*	*bi*	*g*	*ilm*	*zrc*	*Total*	D^{bulk}_{Hf}	D^{bulk}_{Lu}	*Hf (ppm)*	*Lu (ppm)*	*Lu/Hf*	$^{176}Lu/^{177}Hf$
0.177	0.000	0.300	0.000	0.000	0.000	0.237	0.024	0.001	0.739	1.461	2.778	3.58	0.25	0.071	0.0099
0.177	0.000	0.350	0.000	0.000	0.000	0.237	0.024	0.001	0.789	1.369	2.604	3.76	0.27	0.071	0.0100
0.177	0.000	0.400	0.000	0.000	0.000	0.237	0.024	0.001	0.839	1.288	2.450	3.94	0.28	0.072	0.0101
0.177	0.000	0.450	0.000	0.000	0.000	0.237	0.024	0.001	0.889	1.216	2.314	4.11	0.30	0.072	0.0101
0.177	0.000	0.500	0.000	0.000	0.000	0.237	0.024	0.001	0.939	1.151	2.192	4.28	0.31	0.073	0.0102
0.177	0.000	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.660	1.633	3.105	3.28	0.23	0.070	0.0098
0.177	0.000	0.222	0.050	0.000	0.000	0.237	0.024	0.001	0.710	1.519	2.889	3.47	0.25	0.071	0.0099
0.177	0.000	0.222	0.100	0.000	0.000	0.237	0.024	0.001	0.760	1.419	2.701	3.66	0.26	0.071	0.0100
0.177	0.000	0.222	0.150	0.000	0.000	0.237	0.024	0.001	0.810	1.333	2.537	3.84	0.27	0.072	0.0100
0.177	0.000	0.222	0.200	0.000	0.000	0.237	0.024	0.001	0.860	1.256	2.391	4.01	0.29	0.072	0.0101
0.177	0.000	0.222	0.250	0.000	0.000	0.237	0.024	0.001	0.910	1.188	2.262	4.18	0.30	0.072	0.0101
0.177	0.000	0.222	0.300	0.000	0.000	0.237	0.024	0.001	0.960	1.126	2.146	4.35	0.32	0.073	0.0102
0.177	0.000	0.222	0.350	0.000	0.000	0.237	0.024	0.001	1.010	1.071	2.041	4.51	0.33	0.073	0.0102
0.177	0.000	0.222	0.400	0.000	0.000	0.237	0.024	0.001	1.060	1.021	1.947	4.66	0.34	0.074	0.0103
0.177	0.000	0.222	0.450	0.000	0.000	0.237	0.024	0.001	1.110	0.976	1.860	4.81	0.36	0.074	0.0104
0.177	0.000	0.222	0.500	0.000	0.000	0.237	0.024	0.001	1.160	0.934	1.782	4.96	0.37	0.074	0.0104
0.177	0.000	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.660	1.633	3.105	3.28	0.23	0.070	0.0098
0.177	0.000	0.222	0.000	0.025	0.000	0.237	0.024	0.001	0.685	1.587	3.011	3.35	0.24	0.071	0.0099
0.177	0.000	0.222	0.000	0.050	0.000	0.237	0.024	0.001	0.710	1.544	2.923	3.42	0.24	0.071	0.0099
0.177	0.000	0.222	0.000	0.100	0.000	0.237	0.024	0.001	0.760	1.468	2.764	3.56	0.26	0.072	0.0100
0.177	0.000	0.222	0.000	0.150	0.000	0.237	0.024	0.001	0.810	1.401	2.625	3.69	0.27	0.072	0.0101
0.177	0.000	0.222	0.000	0.200	0.000	0.237	0.024	0.001	0.860	1.341	2.502	3.82	0.28	0.073	0.0102
0.177	0.000	0.222	0.000	0.250	0.000	0.237	0.024	0.001	0.910	1.289	2.392	3.94	0.29	0.073	0.0103
0.177	0.000	0.222	0.000	0.300	0.000	0.237	0.024	0.001	0.960	1.241	2.294	4.05	0.30	0.074	0.0103
0.177	0.000	0.222	0.000	0.350	0.000	0.237	0.024	0.001	1.010	1.199	2.206	4.15	0.31	0.074	0.0104
0.177	0.000	0.222	0.000	0.400	0.000	0.237	0.024	0.001	1.060	1.160	2.126	4.25	0.32	0.075	0.0105
0.177	0.000	0.222	0.000	0.450	0.000	0.237	0.024	0.001	1.110	1.125	2.053	4.35	0.33	0.075	0.0106
0.177	0.000	0.222	0.000	0.500	0.000	0.237	0.024	0.001	1.160	1.093	1.987	4.44	0.34	0.076	0.0106

Table 6.2. continued

aug	*opx*	*pl*	*ksp*	*hbl*	*bi*	*g*	*ilm*	*zrc*	*Total*	D^{bulk}_{Hf}	D^{bulk}_{Lu}	*Hf (ppm)*	*Lu (ppm)*	*Lu/Hf*	$^{176}Lu/^{177}Hf$
0.177	0.000	0.222	0.000	0.000	0.000	0.237	0.024	0.001	0.660	1.633	3.105	3.28	0.23	0.070	0.0098
0.177	0.000	0.222	0.000	0.000	0.050	0.237	0.024	0.001	0.710	1.666	2.939	3.23	0.24	0.075	0.0105
0.177	0.000	0.222	0.000	0.000	0.100	0.237	0.024	0.001	0.760	1.694	2.795	3.18	0.25	0.079	0.0111
0.177	0.000	0.222	0.000	0.000	0.150	0.237	0.024	0.001	0.810	1.719	2.668	3.15	0.26	0.084	0.0117
0.177	0.000	0.222	0.000	0.000	0.200	0.237	0.024	0.001	0.860	1.741	2.556	3.11	0.27	0.088	0.0123
0.177	0.000	0.222	0.000	0.000	0.250	0.237	0.024	0.001	0.910	1.761	2.456	3.09	0.28	0.091	0.0128
0.177	0.000	0.222	0.000	0.000	0.300	0.237	0.024	0.001	0.960	1.779	2.367	3.06	0.29	0.095	0.0133
0.177	0.000	0.222	0.000	0.000	0.350	0.237	0.024	0.001	1.010	1.795	2.287	3.04	0.30	0.099	0.0138
0.177	0.000	0.222	0.000	0.000	0.400	0.237	0.024	0.001	1.060	1.809	2.214	3.02	0.31	0.102	0.0143
0.177	0.000	0.222	0.000	0.000	0.450	0.237	0.024	0.001	1.110	1.822	2.148	3.00	0.32	0.105	0.0147
0.177	0.000	0.222	0.000	0.000	0.500	0.237	0.024	0.001	1.160	1.834	2.087	2.99	0.32	0.108	0.0152
0.177	0.000	0.222	0.000	0.000	0.000	0.000	0.024	0.001	0.423	2.419	1.763	2.37	0.37	0.157	0.0219
0.177	0.000	0.222	0.000	0.000	0.000	0.025	0.024	0.001	0.448	2.297	1.972	2.48	0.34	0.137	0.0192
0.177	0.000	0.222	0.000	0.000	0.000	0.050	0.024	0.001	0.473	2.187	2.158	2.58	0.31	0.122	0.0171
0.177	0.000	0.222	0.000	0.000	0.000	0.100	0.024	0.001	0.523	2.000	2.478	2.78	0.28	0.101	0.0141
0.177	0.000	0.222	0.000	0.000	0.000	0.150	0.024	0.001	0.573	1.846	2.741	2.97	0.26	0.086	0.0121
0.177	0.000	0.222	0.000	0.000	0.000	0.200	0.024	0.001	0.623	1.716	2.963	3.15	0.24	0.076	0.0107
0.177	0.000	0.222	0.000	0.000	0.000	0.250	0.024	0.001	0.673	1.606	3.151	3.32	0.23	0.068	0.0096
0.177	0.000	0.222	0.000	0.000	0.000	0.300	0.024	0.001	0.723	1.511	3.313	3.48	0.22	0.062	0.0087
0.177	0.000	0.222	0.000	0.000	0.000	0.350	0.024	0.001	0.773	1.428	3.455	3.64	0.21	0.058	0.0081
0.177	0.000	0.222	0.000	0.000	0.000	0.400	0.024	0.001	0.823	1.355	3.579	3.79	0.20	0.054	0.0075
0.177	0.000	0.222	0.000	0.000	0.000	0.450	0.024	0.001	0.873	1.291	3.689	3.93	0.20	0.050	0.0070
0.177	0.000	0.222	0.000	0.000	0.000	0.500	0.024	0.001	0.923	1.233	3.787	4.07	0.19	0.048	0.0067

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