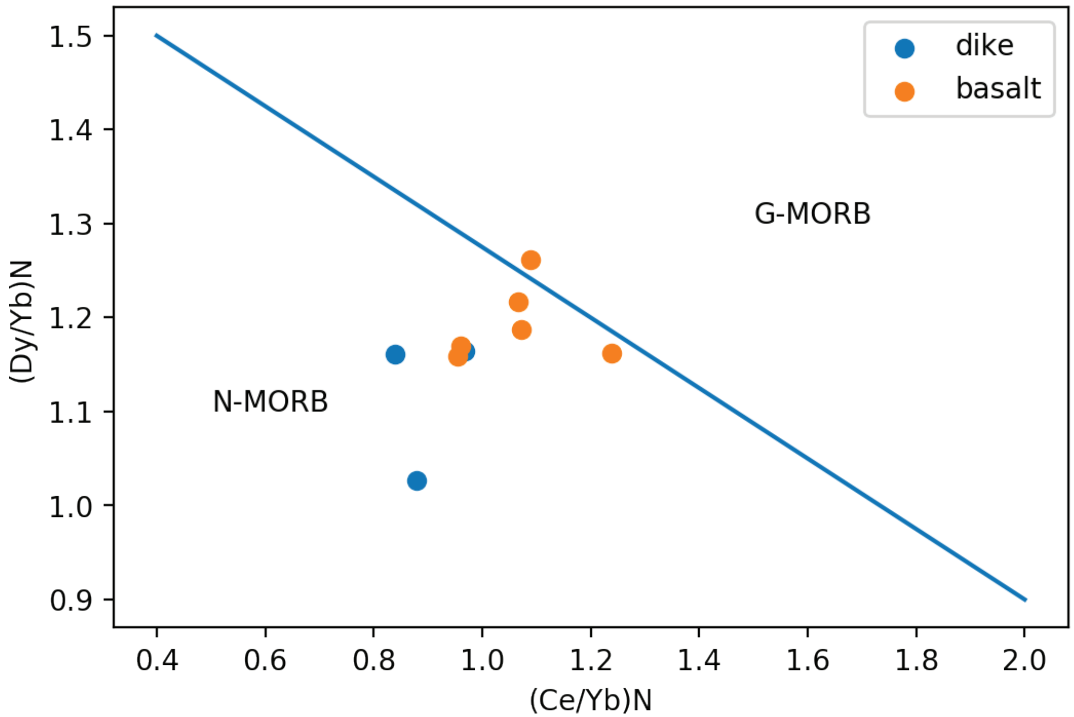

Figure S1. (Ce/Yb)N versus (Dy/Yb)N discrimination diagram of Saccani (2014) with G-MORB indicating a garnet-influenced MORB.

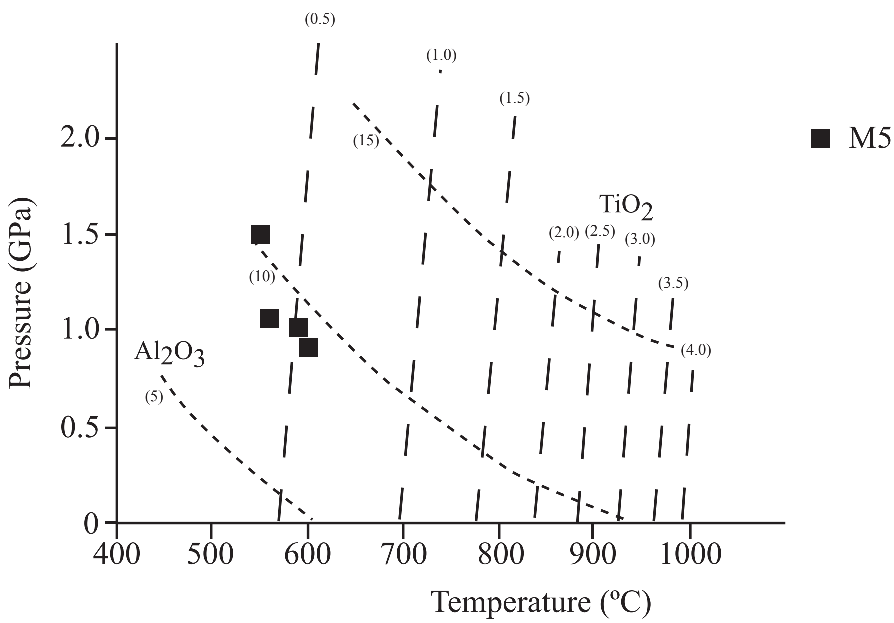

Figure S2. P-T estimates of hornblende in gabbrobased on the Al- and Ti-in-hornblende semiquantitative thermobarometer of Ernst and Liu (1998).

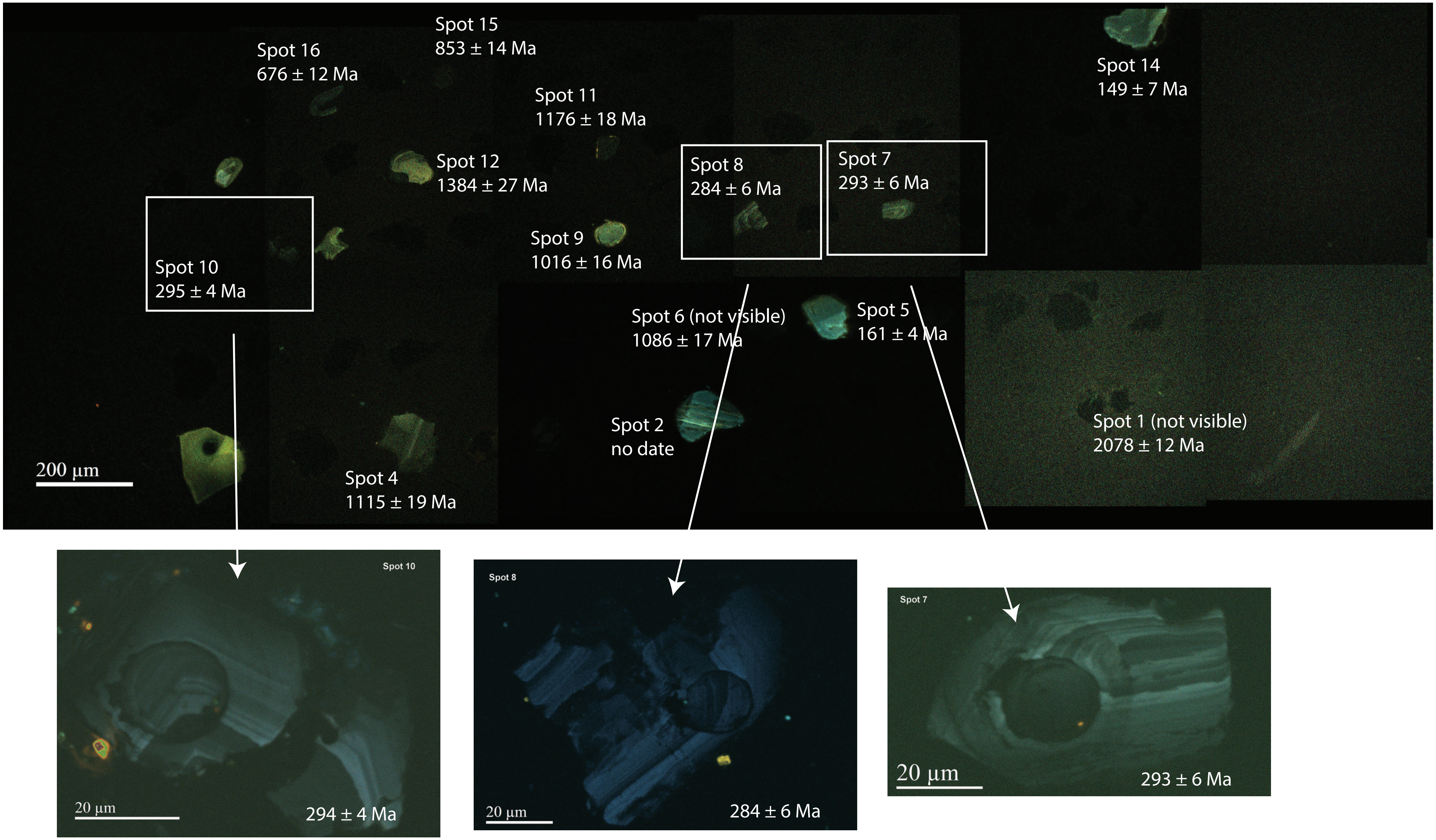

Figure S3. Cathodoluminescence of zircons from an albitite segregation at Timpa di Pietrasasso with LA-ICP-MS $^{206}Pb/^{238}U$ dates. Detail shown for the three youngest zircons that show oscillatory zoning; laser pit is visible in images. Full data shown in Table DR1.

Table S1. U-Pb geochronologic analyses.

						Isotope ratios					Apparent ages (Ma)					
Analysis	U (ppm)	206Pb 204Pb	U/Th	206Pb* 207Pb*	± (%)	207Pb* 235U*	± (%)	206Pb* 238U	± (%)	error corr.	206Pb* 238U*	± (Ma)	207Pb* 235U	± (Ma)	206Pb* 207Pb*	± (Ma)
Spot 14	9	154	2.0	22.4176	45.0	0.1440	45.2	0.0234	4.5	0.10	149	7	137	58	NA	NA
Spot 5	28	433	2.7	53.9047	79.0	0.0647	79.1	0.0253	2.5	0.03	161	4	64	49	NA	NA
Spot 8	1312	31427	3.2	19.3260	0.9	0.3208	2.3	0.0450	2.2	0.93	284	6	283	6	274	20
Spot 7	1485	116413	2.6	19.0332	0.7	0.3362	2.1	0.0464	2.0	0.94	293	6	294	5	309	17
Spot 10	1459	89699	2.3	19.2398	0.7	0.3352	1.6	0.0468	1.4	0.89	295	4	294	4	284	17
Spot 16	379	101806	1.9	15.9418	0.8	0.9554	2.0	0.1105	1.8	0.91	676	12	681	10	699	18
Spot 15	292	42818	2.0	14.3240	0.8	1.3615	1.9	0.1415	1.8	0.90	853	14	873	11	923	17
Spot 9	162	80185	2.4	13.5575	0.8	1.7345	1.9	0.1706	1.7	0.90	1016	16	1021	12	1035	16
Spot 6	118	9680	1.9	13.3573	1.3	1.8940	2.1	0.1836	1.7	0.80	1086	17	1079	14	1065	26
Spot 4	105	7800	2.4	13.0300	0.9	2.0575	2.0	0.1945	1.7	0.88	1146	18	1135	13	1115	19
Spot 11	493	459729	2.4	12.5129	0.9	2.2047	1.9	0.2002	1.7	0.89	1176	18	1183	13	1195	17
Spot 12	84	1615544	3.2	11.3717	1.0	2.9013	2.4	0.2394	2.2	0.90	1384	27	1382	18	1381	20
Spot 1	676	306716	4.4	7.7820	0.7	6.9791	1.8	0.3941	1.6	0.92	2142	30	2109	16	2078	12

Table S2. LA-ICP-MS analytical settings

Analytical Settings for U-Pb Geochronology at the Arizona LaserChron Center (Element 2 Single Collector)

Laboratory and Sample Preparation	
Laboratory name	Arizona LaserChron Center
Sample type/mineral	Zircon
Sample preparation	Conventional mineral separation, 1 inch epoxy mount, polished to 1-micron finish
Imaging	Hitachi 3400N SEM with BSE and/or Cathodoluminesence
Laser ablation system	
Make, Model, and type	Photon Machines Analyte G2 Excimer laser
Ablation cell and volume	HelEx ablation cell
Laser wavelength	193 nm
Pulse width	~8 ns
Energy density	~7 J/cm2
Repetition rate	7 Hz
Alation duration	10 s
Ablation pit depth/ablation rate	~12 microns & 0.8 microns/sec
Spot diameter nominal/actual	20 microns
Sampling mode/pattern	Spot
Carrier gas	Helium
Cell carrier gas flow	0.11 L/min He in inner cup, 0.29 L/min He in cell
ICP-MS instrument	
Make, Model, and type	Thermo Element2 HR ICPMS
Sample introduction	Ablation aerosol
RF power	1200 W
Make-up gas flow	0.8 L/min Ar
Detection system	Dual mode Secondary Electron Multiplier
Masses measured	202Hg, 204(Hg+Pb), 206Pb, 207Pb, 208Pb, 232Th, 235U, 238U
Dwell times (ms)	202=5.2, 204=7.8, 206=20.2, 207=28.4, 208=2.6, 232=2.6, 235=15.4, 238=10.4
Total integration time per output data point (sec)	202=1.5, 204=2.3, 206=5.9, 207=8.3, 208=0.7, 232=0.7, 235=4.5, 238=3.0
Sensitivity as useful yield	~5000 cps/ppm
IC dead time	22 ns
Data processing	
Gas blank	8 sec on-peak zero subtracted
Calibration strategy	FC-1 zircon used as primary standard
Reference material information	Gehrels et al. (2008)
Data processing package used/Correction for LIEF	E2agecalc
Mass discrimination	Normalized to primary standard
Common Pb correction, composition and uncertainty	Common Pb correction based on measured 206Pb/204 Pb and the assumed composition of common Pb based on Stacey and Kramers (1975)
Uncertainty level and propagation	Uncertainties for individual analyses propagated at 2-sigma. Uncertainty of pooled analyses propagated at 2-sigma.
Quality control/validation	SLM and R33 analyzed as secondary standards.
Other information	Primary and secondary standards mounted together with unknowns.
	Analytical methods described by Gehrels et al. (2008), Gehrels and Pecha (2014), and Pullen et al. (2018)

Citations:

Gehrels, G.E., Valencia, V., Ruiz, J., 2008, Enhanced precision, accuracy, efficiency, and spatial resolution of U-Pb ages by laser ablation–multicollector–inductively coupled plasma–mass spectrometry: Geochemistry, Geophysics, Geosystems, v. 9, Q03017, doi:10.1029/2007GC001805.

Gehrels, G. and Pecha, M., 2014, Detrital zircon U-Pb geochronology and Hf isotope geochemistry of Paleozoic and Triassic passive margin strata of western North America: Geosphere, v. 10 (1), p. 49-65.

Pullen, A., Ibanez-Mejia, M., Gehrels, G., Giesler, D., and Pecha, M., 2018, Optimization of a Laser Ablation-Single Collector-Inductively Coupled Plasma-Mass Spectrometer (Thermo Element 2) for Accurate, Precise, and Efficient Zircon U-Th-Pb Geochronology: Geochemistry, Geophysics, Geosystems, v. 19. https://doi. org/10.1029/2018GC007889

Stacey, J., and Kramers, J., 1975, Approximation of terrestrial lead isotope evolution by a two-stage model: Earth and Planetary Science Letters, v. 26, p. 207 221.