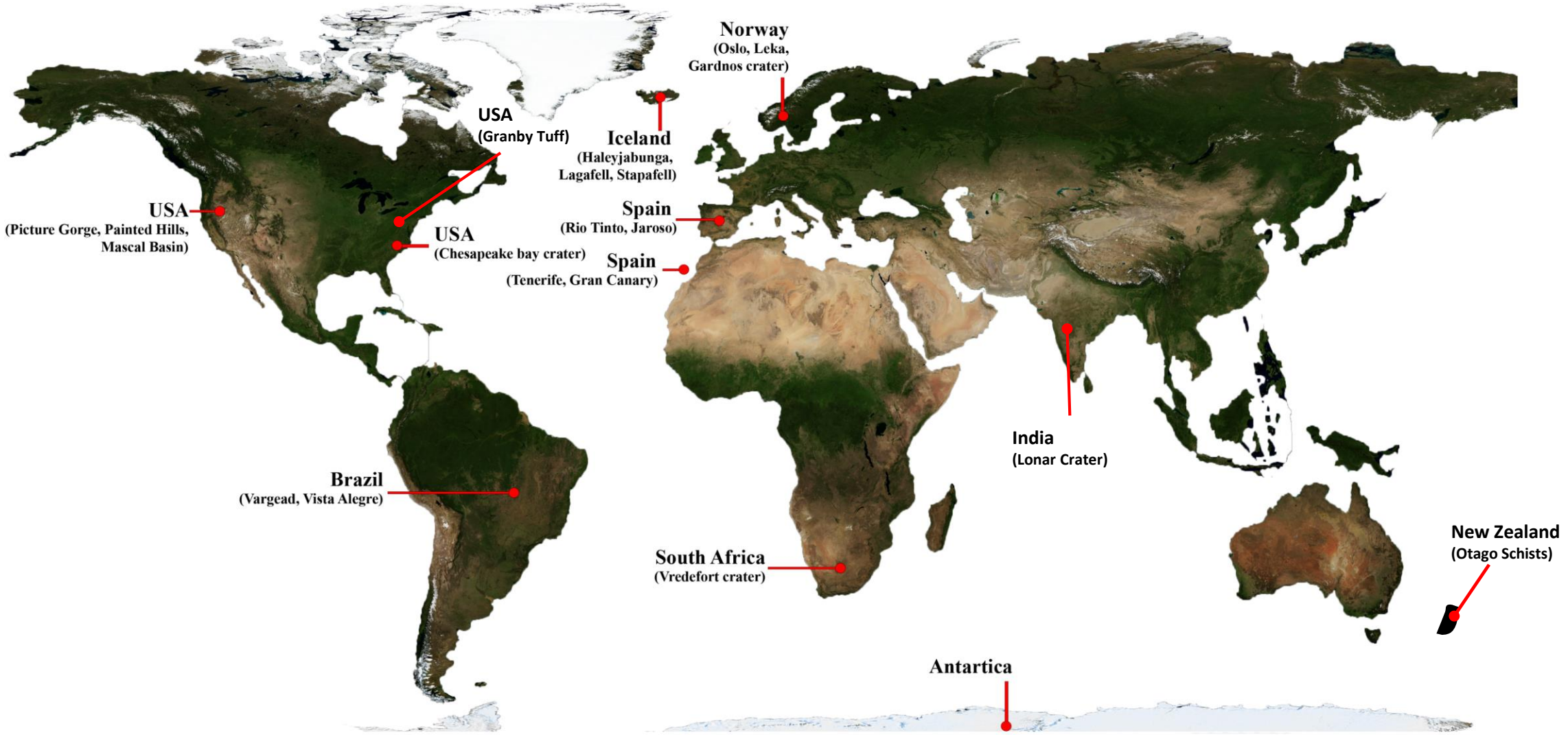
Planetary Terrestrial Analogue Library (PTAL): Collection details

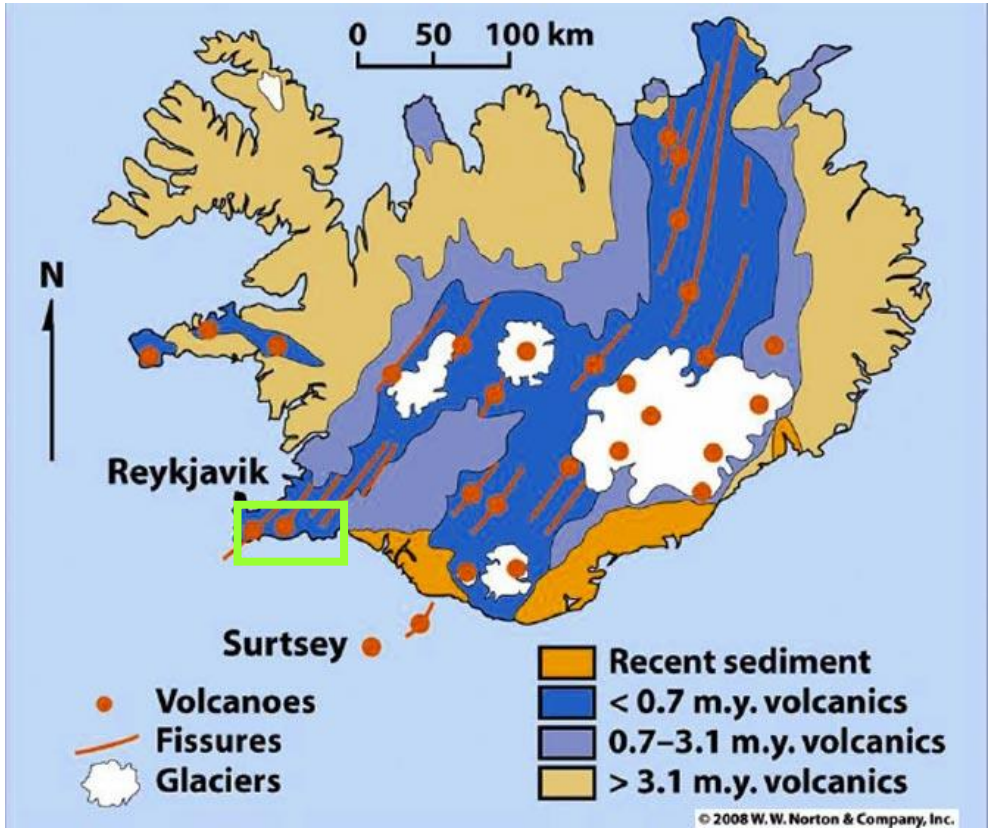
PTAL terrestrial analogues sites



PTAL terrestrial analogue sites overview

- **Iceland**
- Canary Islands
- Oslo Rift
- Leka ophiolite
- John Day, Oregon
- Rum, Scotland
- Granby Tuffs
- Jaroso Ravine
- Rio Tinto
- Otago schists

Geology



- One of the most active volcanic regions on Earth – all types of volcanism and geothermal activity.
- Combination of Iceland plume hot spot volcanism (deep primordial mantle source) and MORBs – shallow depleted mantle source.
- Basalts and gabbroic xenoliths.
- Samples collected from Reykjavik region, <700 k.y. volcanism.

Highlight: recent tholeiitic basalt from depleted mantle

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Sampling sites

- 16 samples from 5 sites, with masses 77 g-650 g.
- Ferropicrites, tholeiitic pillow lava and sand of tholeiitic lava, solfatara precipitates.
- Minor alteration in hydorthermal conditions: hematite, pyrite, native sulfur, zeolites, carbonates, hydrated silica, phyllosilicates.

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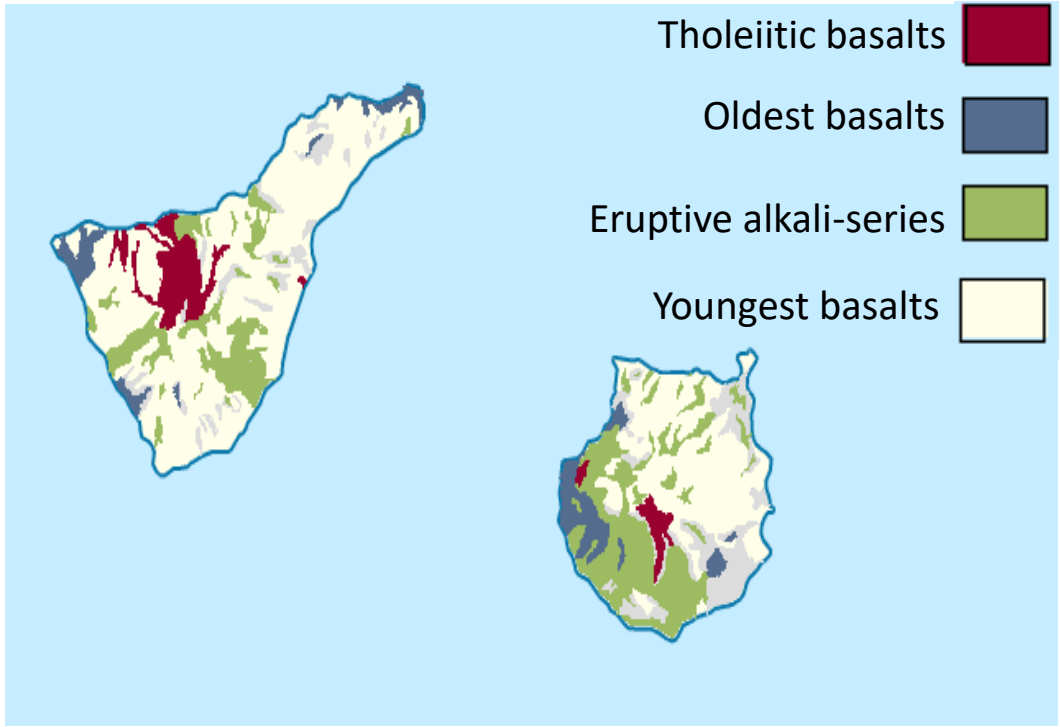
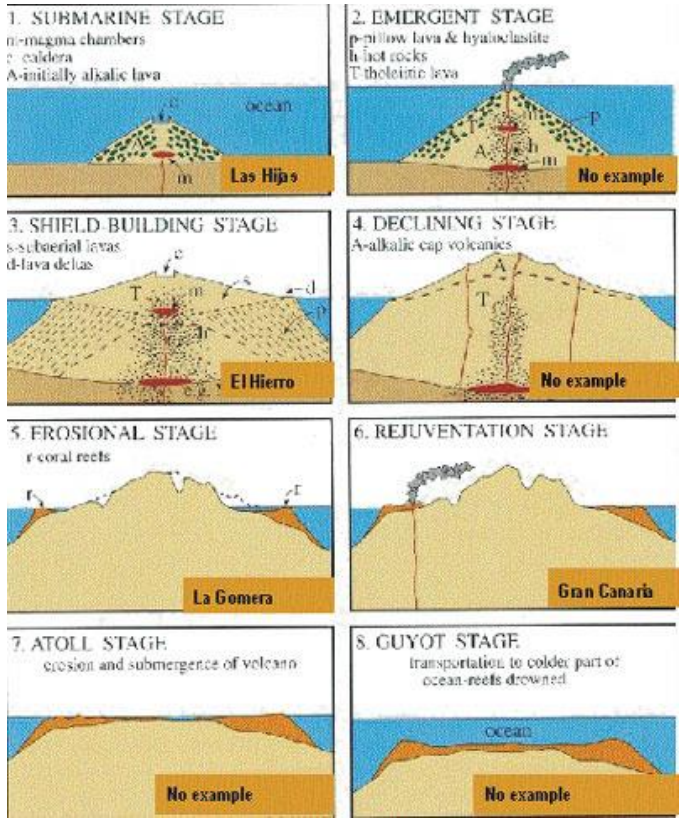
Geology

- ‘Hawaii-type’ chain volcanos with several stages of evolution: pre-shield, shield-volcano, rejuvenation, developed at a passive continental margin.
- Oldest units – tholeiitic rocks, Rejuvenation stage – ultra-alkaline rocks, naphelinites, basanites, phonolites.



Highlight: recent alkali basalt from metasomatized source



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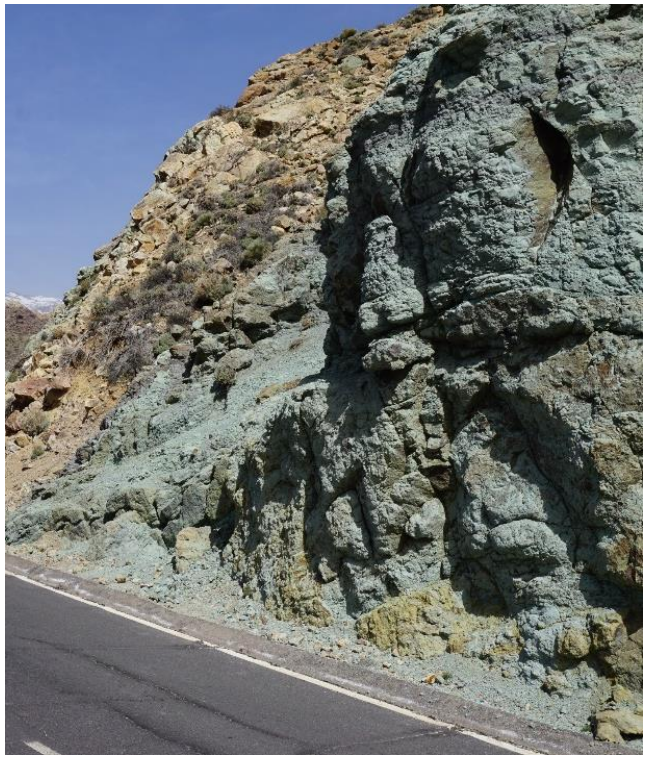
Sampling sites

- In total 18 samples from 9 sites, with masses 66 g-765 g.
- Phonolites, basanites
- Altered phonolites with hematite, carbonates, zeolites, smectites, sulfates and sulfides.



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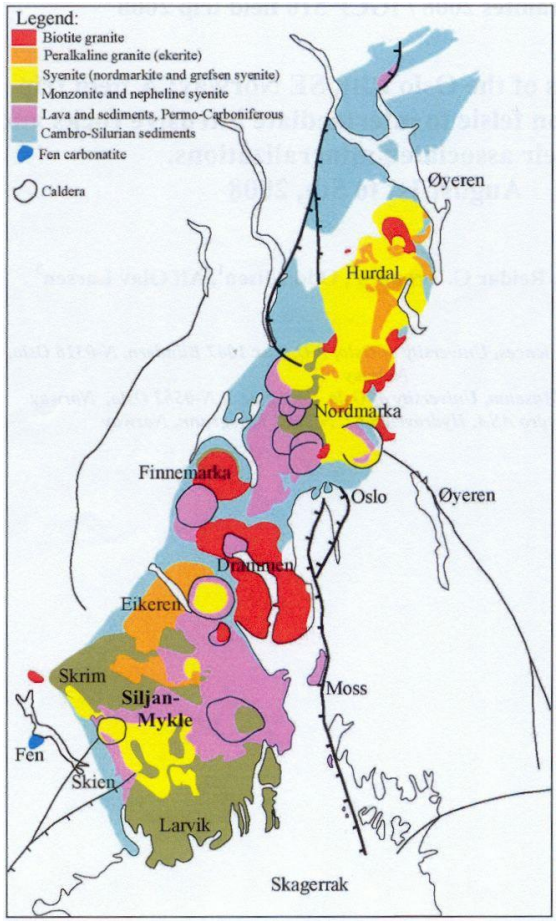

- Permian (310-240Ma) rift valley
- Characteristic plutonic rocks, magma plumbing system of volcanic rift zone
- Derived from mantle source via deep crustal magma chambers → extensive fractional crystallization and contamination.
- Fe and Ti-rich gabbros.
- Associated by hydrothermal activity

Highlight: Ti and Fe-rich basalt, compositionally similar to martian surface

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Sampling sites

- Sampling in Ullernåsen and Brattåsen
- 3 samples of Fe,Ti-rich gabbros, each ~1kg in mass.

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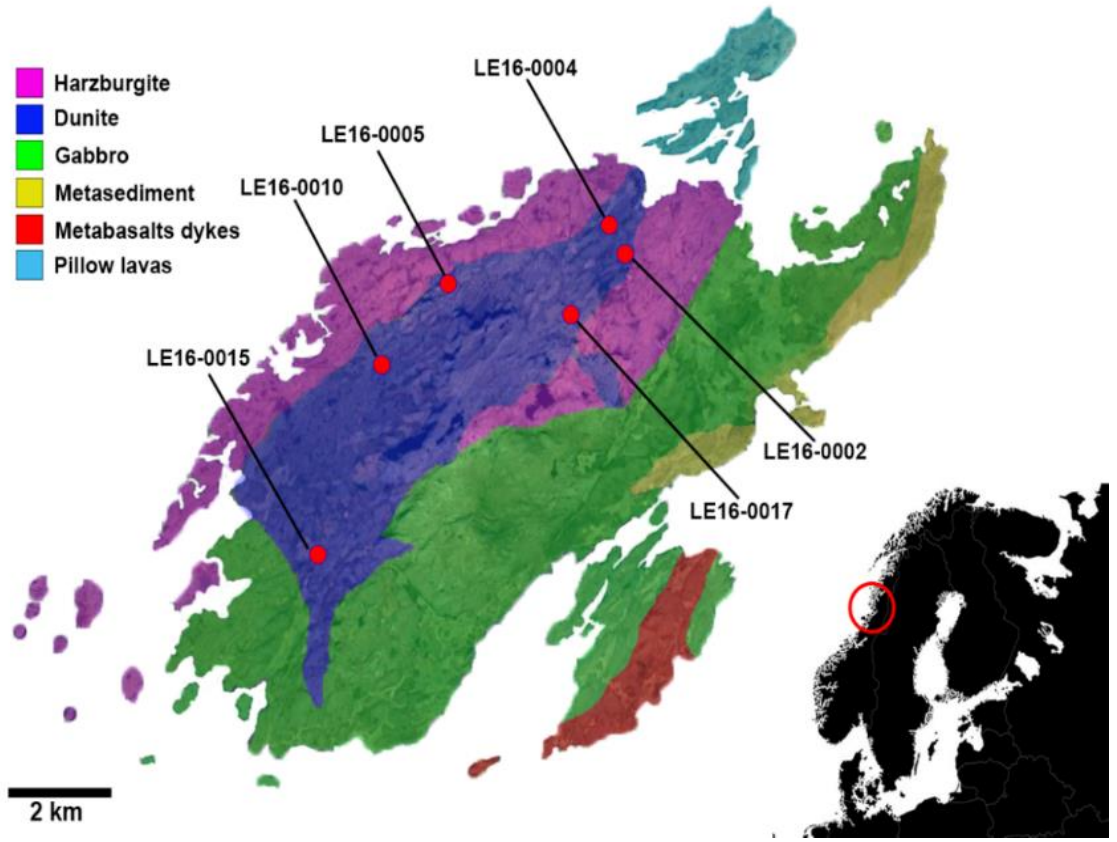

- Late Cambrian ophiolite complex, related to supra-subduction zone, exhumed mantle.
- Rich in ultramafic rocks: dunites, harzburgites, pyroxenites, and gabbros - tholeiites.
- Metamorphosed.
- Partly and completely serpentinized and carbonated peridotites.

Highlight: serpentinized and carbonated ultramafic and mafic rocks

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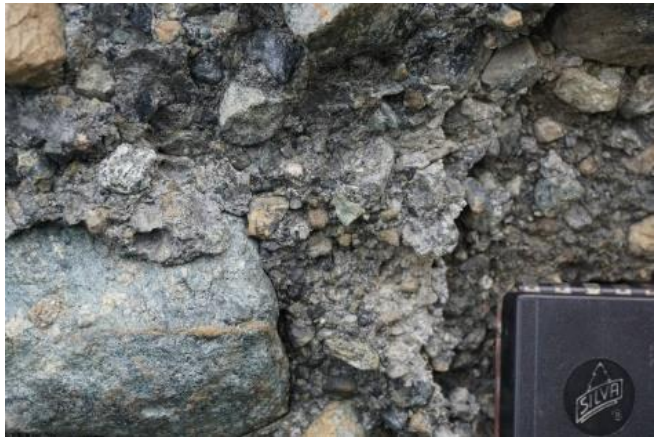
Sampling sites



- 17 samples with masses of 170 – 764 g
- Dunites, harzburgites, wehrlites partly and completely serpentinized, also carbonated serpentinites and talc-carbonate rocks.
- Gabbros with chlorite as alteration product

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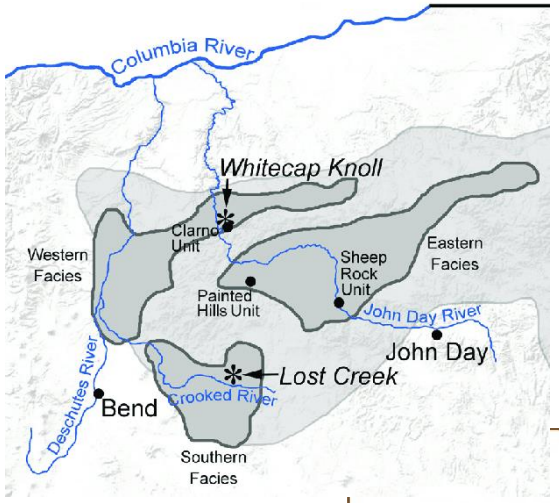
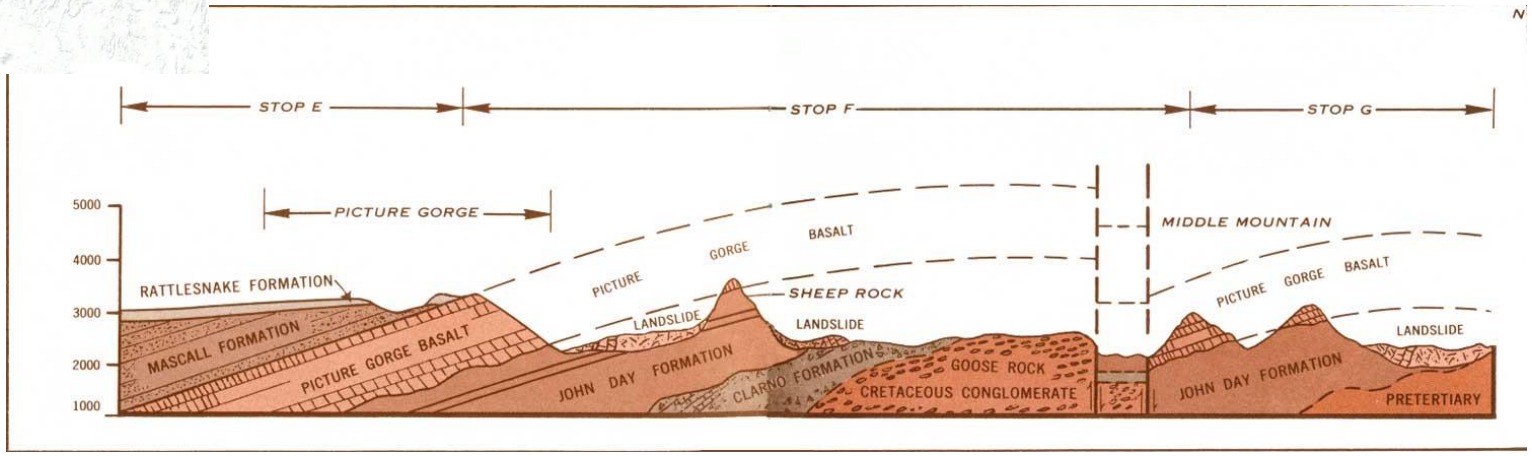


- JD formation in Oregon – basaltic lavas and altered melt rocks.
- basaltic volcanic rocks and volcanic ashes (tuffs) sequence. Andesitic to dacitic pyroclastis material.
- Have been proposed as good analogue for extended Mawrth Vallis deposits



Highlight: Weathering profile of basaltic-andesitic pyroclastics

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Sampling sites

- In total 26 samples from 3 sites (John Day Valley, Painted Hills and Clarno), with masses 150 g-600 g.
- Basalts, alkali-olivine basalts, andesites – all weathered and unweathered. Also, paleosols
- Alteration in surface weathering conditions.

- Hancock Station

- Painted Hill andesite site

- Picture George

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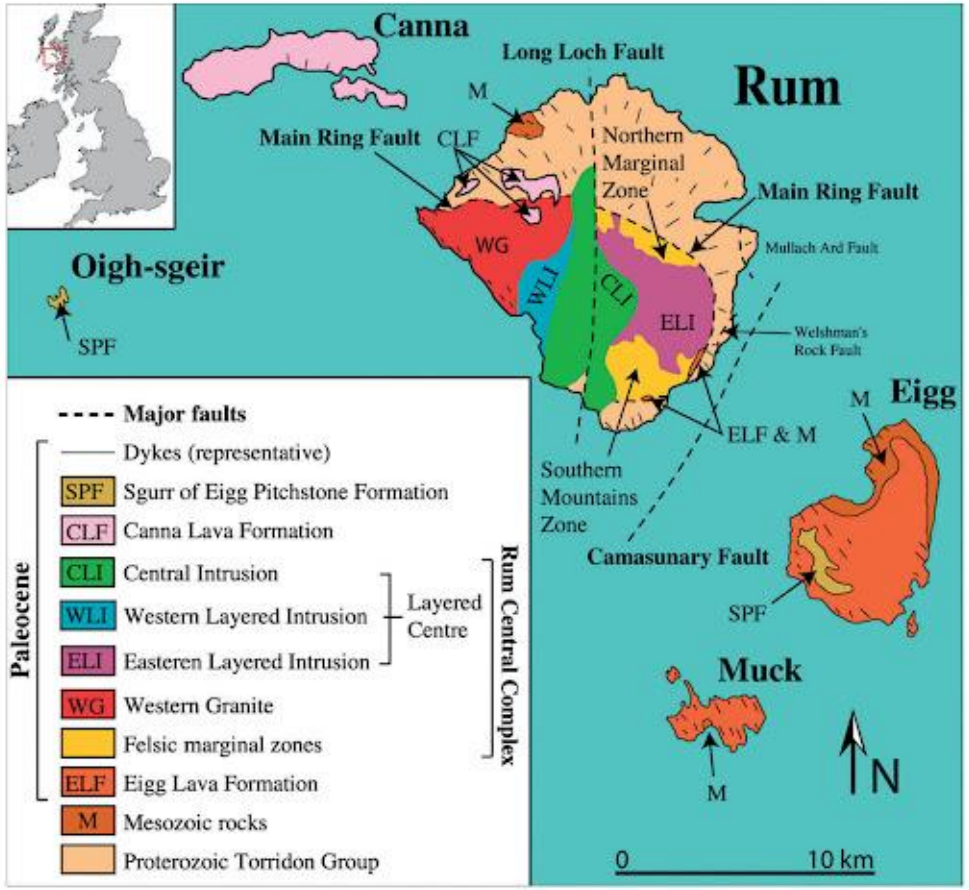
Geology



- Rum island in Scotland – eroded after early Paleogene volcanic centre that was active during opening of North Atlantic.
- Layered ultramafic rocks are remnants of volcano-feeding magma chamber
- Parent magma was either high-temperature picritic basalt or feldspathic peridotite

Highlight: ferropicritic rocks

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Sampling sites

- 1 sample of ferropicrite, 150 g in mass, was donated to PTAL

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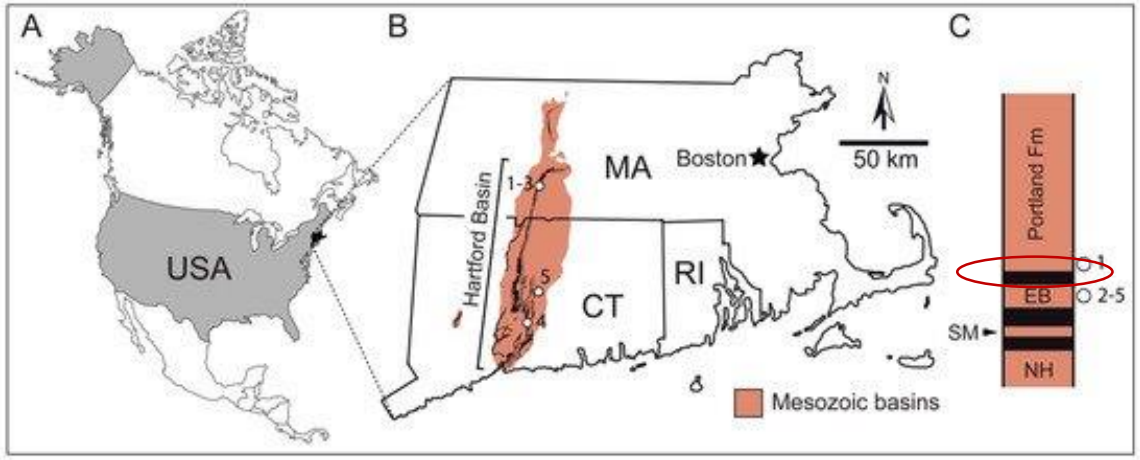
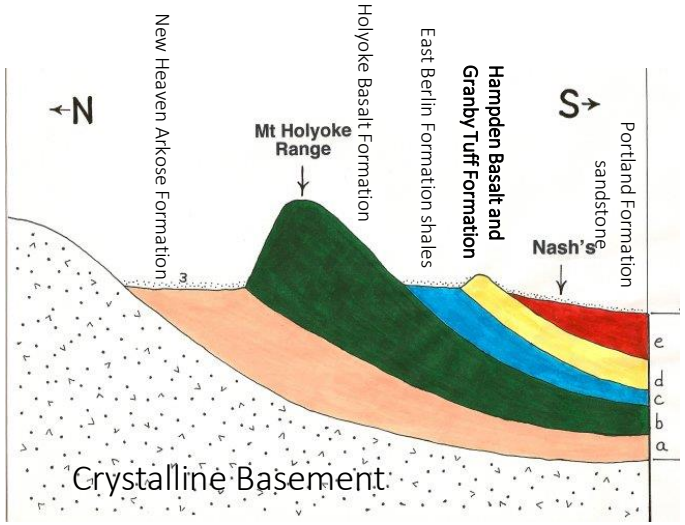
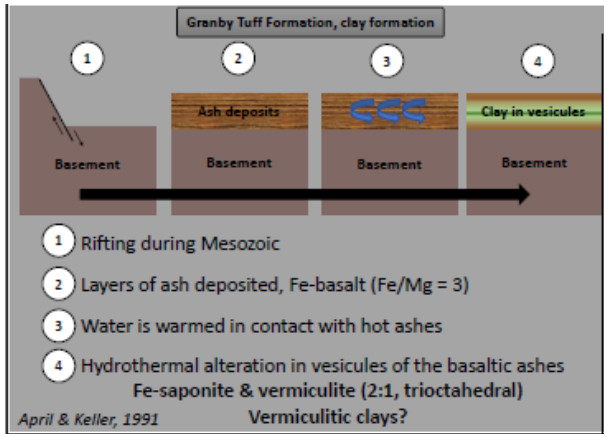




- Hartford rift basin (Mesozoic), Connecticut.
- Hampden Basalts and Granby Tuff formation – basalt flow intertwinned. with volcanic ash (pyroclastics).
- Samples of vesicular basalts with amygdales



Highlight: Basaltic tuff with trioctahedral clays (vermiculite)

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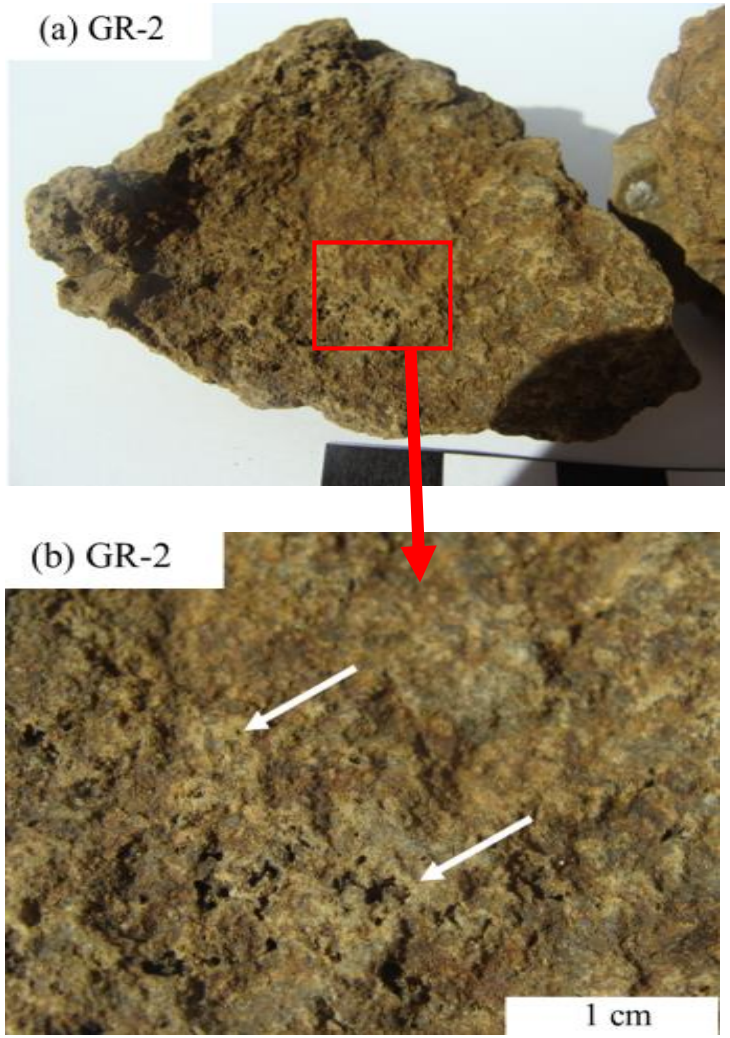
Sampling sites

- Sampling from Scenic View outcrop
- 4 samples of vesicular basalt with masses 50-400 g.
- Contain Fe-rich, trioctahedral vermiculite + saponite



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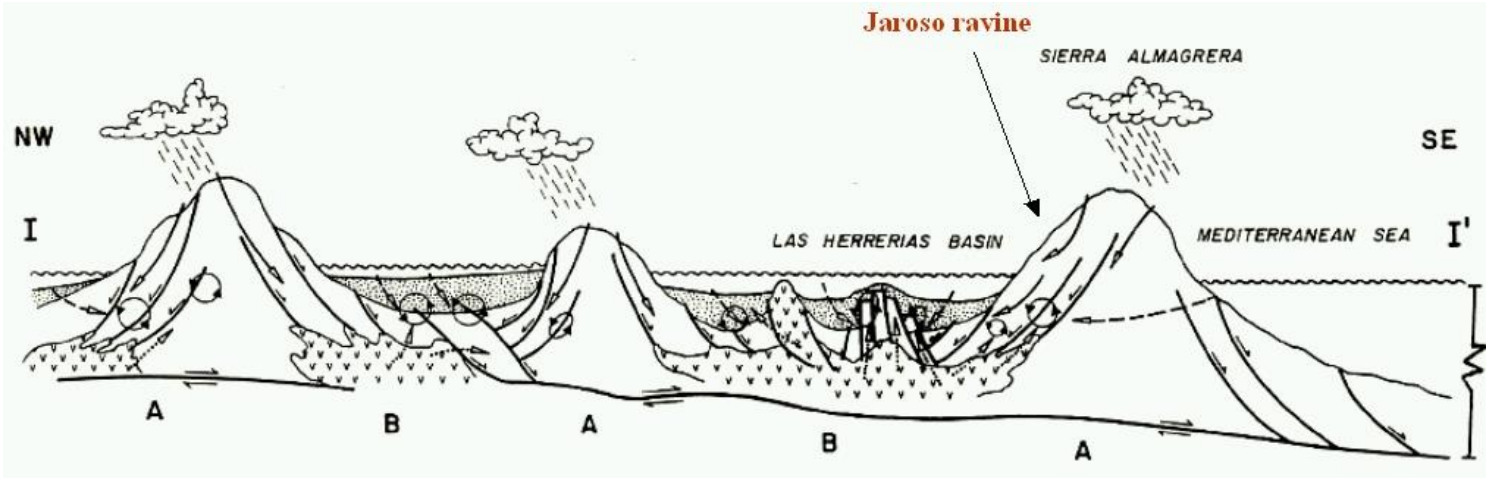

- Calc-alkaline or shoshonitic volcanism
- Late volcanic hydrothermal and supergenic jarosite
- Precipitation in semiarid climate.

Highlight: Type location of jarosite – Fe-sulfate

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Sampling sites

- 3 samples, with masses 17 g-50g
- Weathered pegamtites and mica schists
- Contain jarosite and clays

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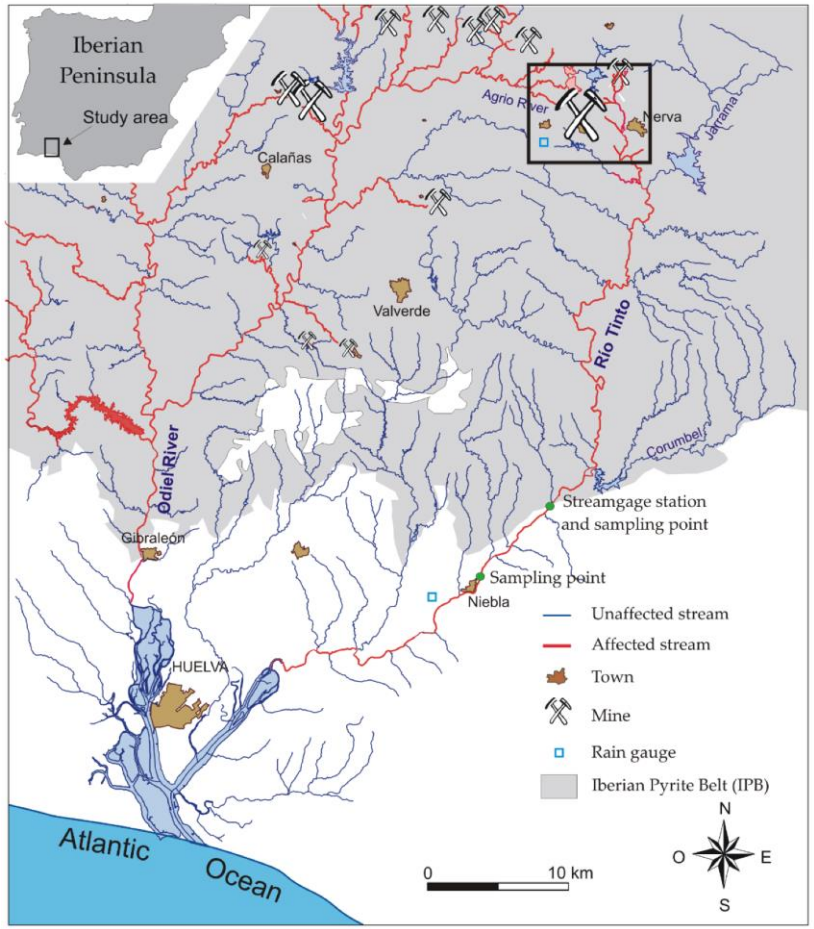
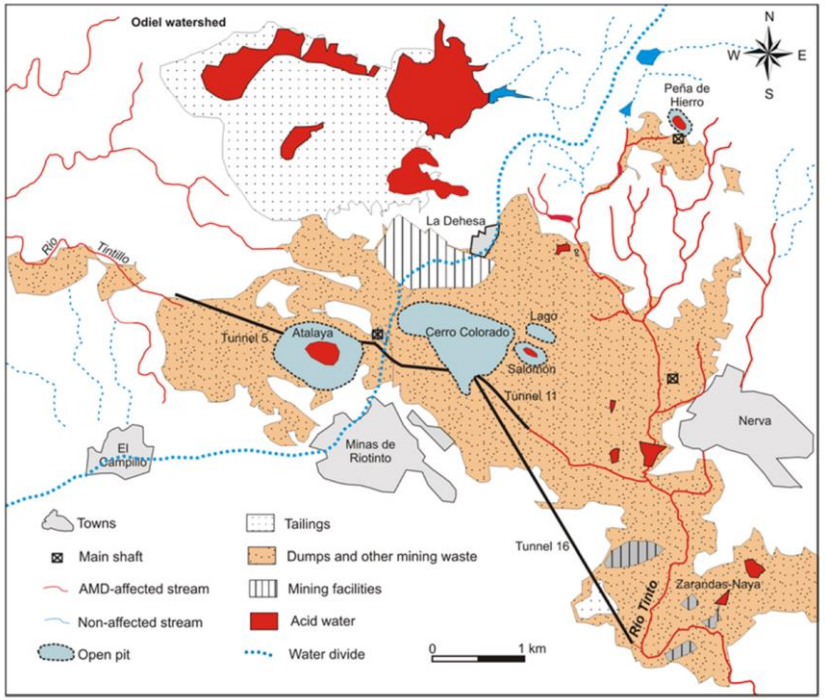


Highlight: Acid weathering of sulfides

- River deposits associated with very acidic (pH=2) drainage and water containing dissolved Fe.
- Acid mine drainage in Iberian Pyrite Belt, that hosts large amount of ore and sulfide deposits.



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Sampling sites

- 3 samples, with masses 13 g-130 g
- Contain sulfides, sulfates and iron oxides

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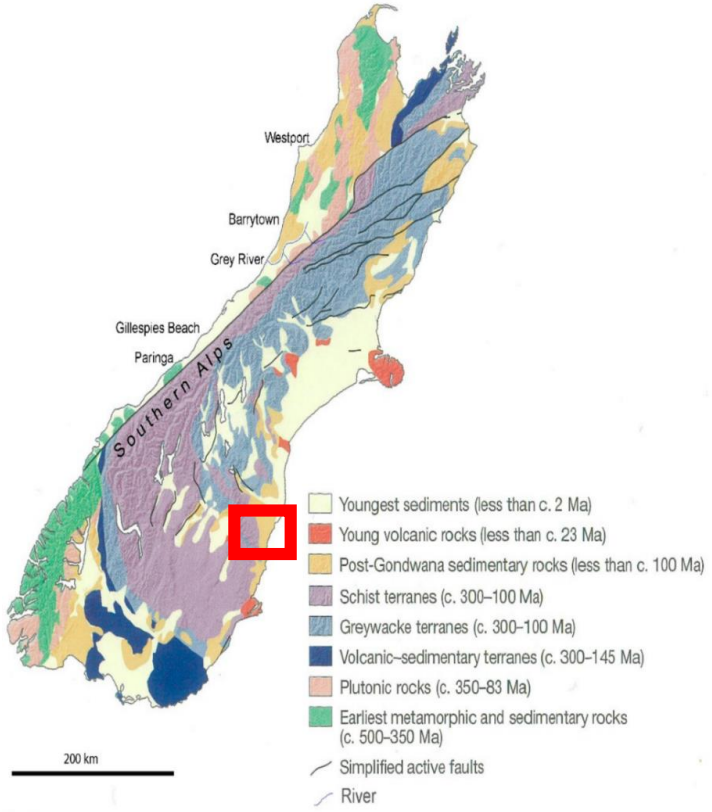
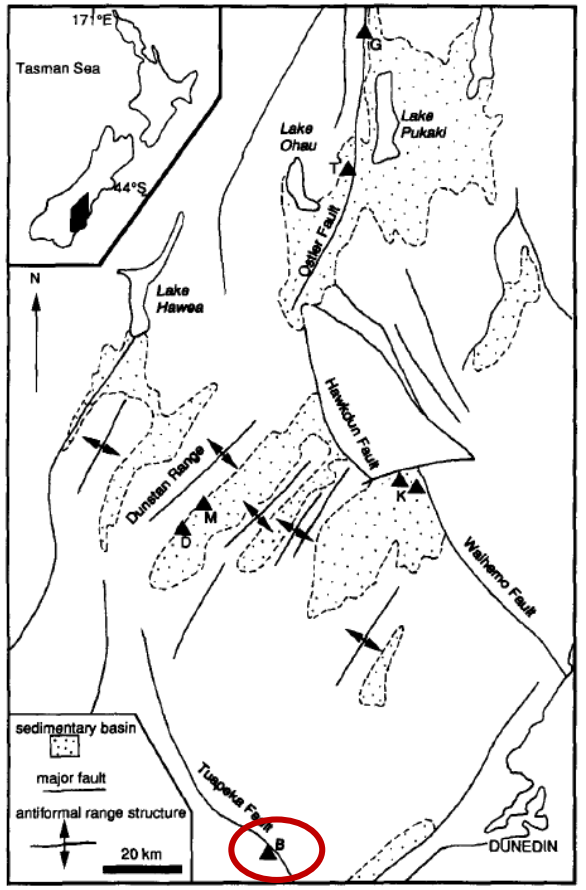
Geology





- Basement metamorphosed Fe-chlorite-bearing schists.
- Late Cretaceous-Paleogene extension, fault formation.
- Deposition along scarps. Short transport and limited oxidation of chlorite → vermiculite.
- Significant content of organic matter enabled anoxic, reduced conditions.
- Alteration during diagenesis → groundwaters and not transport → illitization of vermiculite (Al).

Highlight: Trioctahedral-vermiculite formed anoxically after chlorite

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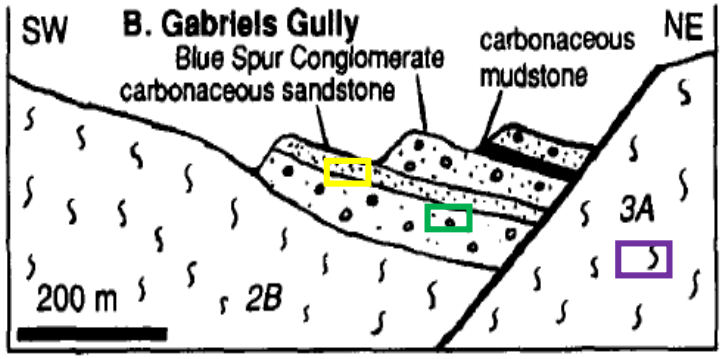
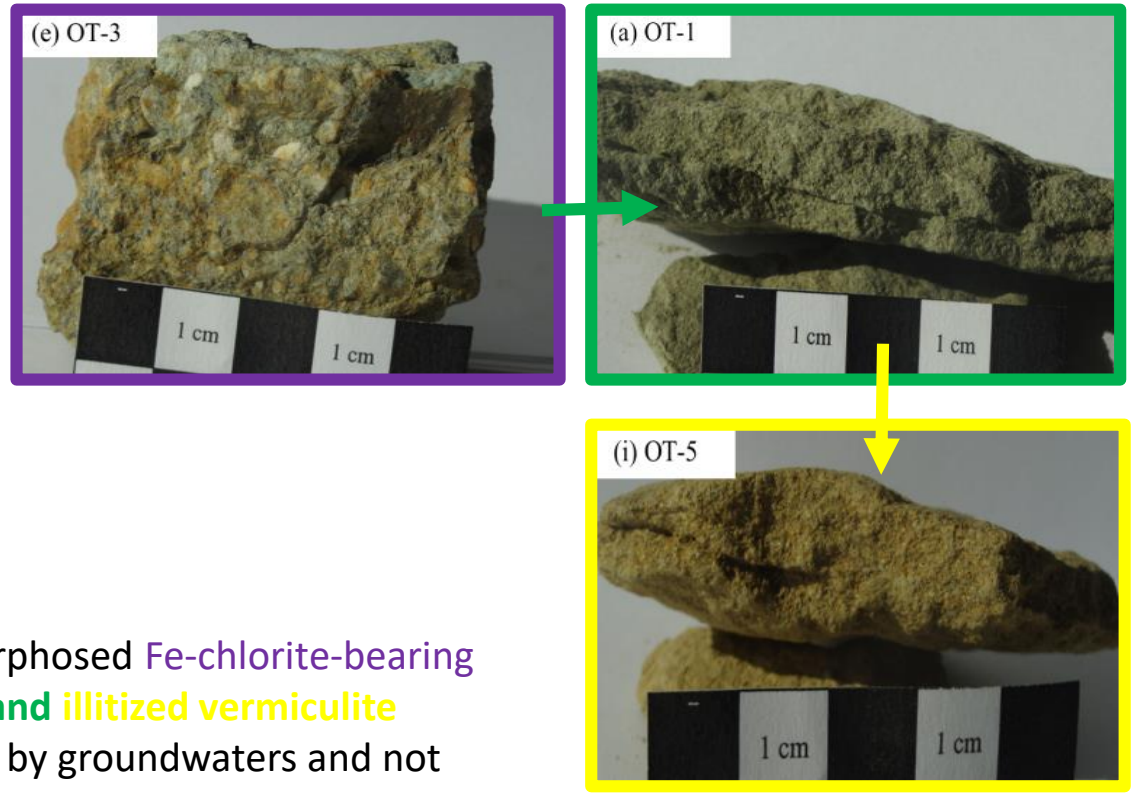
Sampling sites

- Sampling from old gold mine within Blue Spur Conglomerate





- 5 samples, 200-500g in mass
- Samples represent: basement metamorphosed Fe-chlorite-bearing schists, **vermiculitized chlorite schists and illitized vermiculite** formed via alteration during diagenesis by groundwaters and not transport.

PTAL terrestrial analogue sites overview

Gardnos

Vredefort

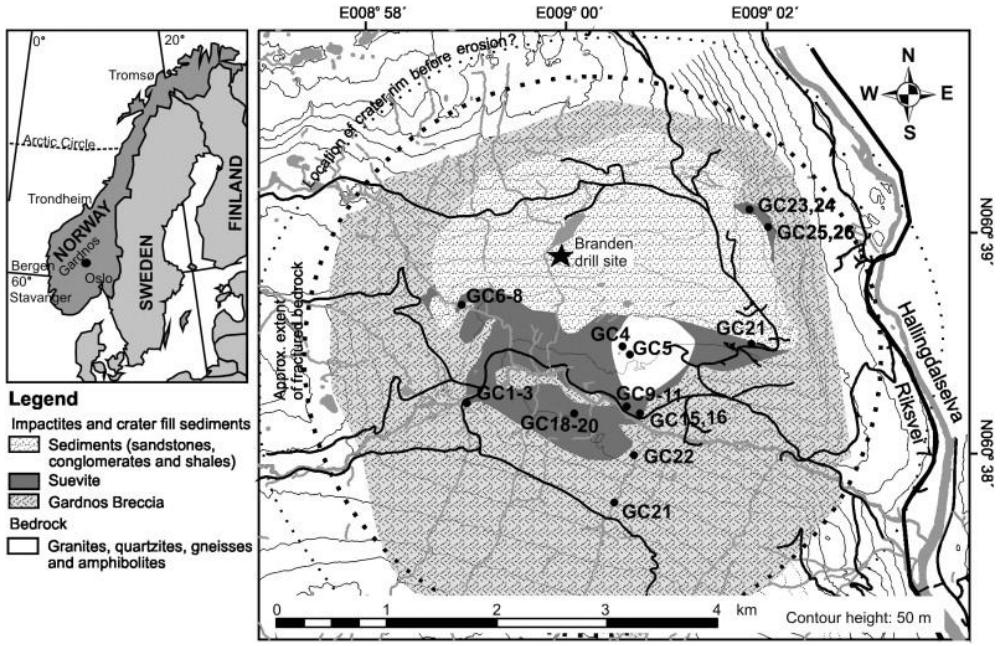
Chesapeake Bay

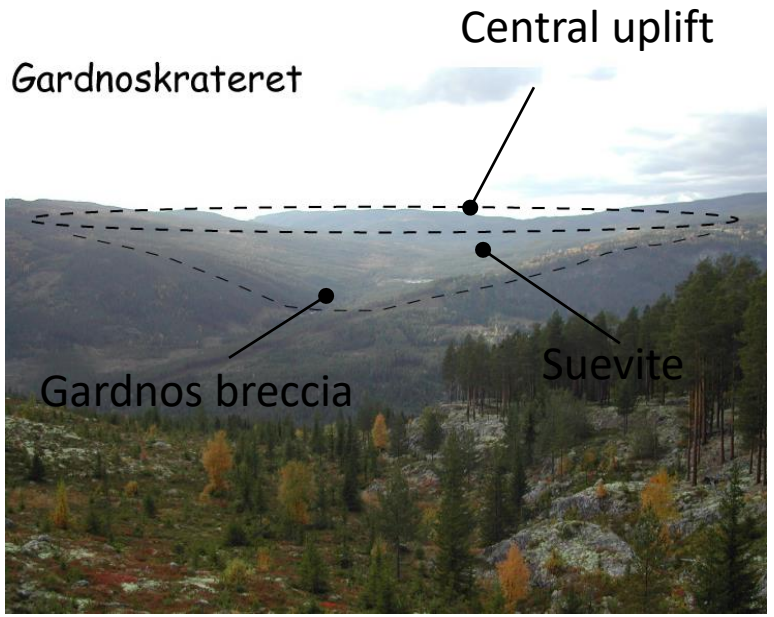
Lonar

Vargeao Dome

Geology

- 5 km in diameter, complex crater
- Formed ~546 Ma in granitic gneisses and quarzites of Precambrian basement. Basement was overlain by shales in time of impact.





Highlight: Impact melt rich in organic matter

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Gardnos

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Lonar

Vargeao Dome

Sampling sites

- 1 sample of impact melt, 100 g in mass
- Melt rich in chlorite, amphibole and feldspars
- Matrix rich in organic matter

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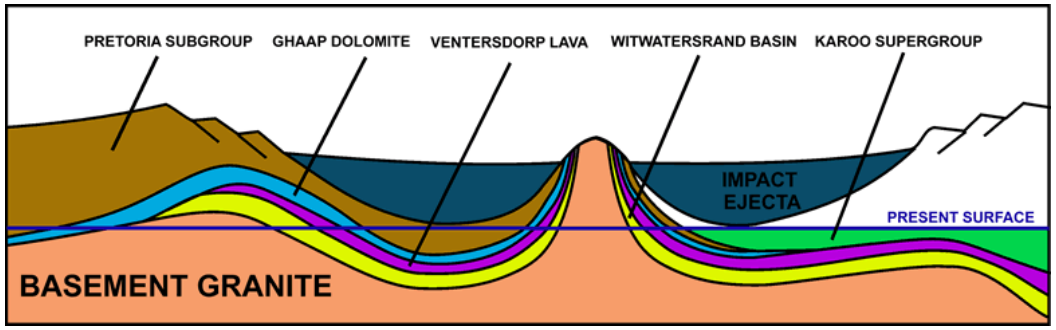
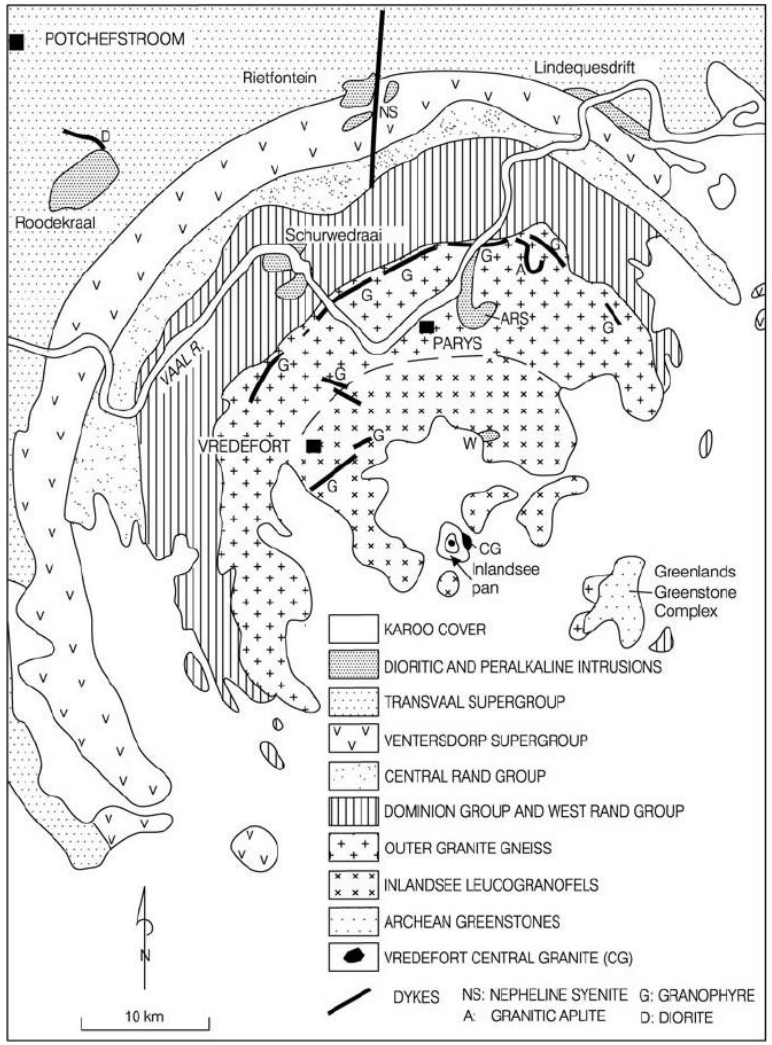


- 2 Ga old crater, oldest known on the Earth
- Originally 160-300 km across, now siginificantly destructed
- Target rock was granite



Highlight: Archean crater

PTAL terrestrial analogue sites overview

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Sampling sites

- 1 sample of impact melt, 130 g in mass available

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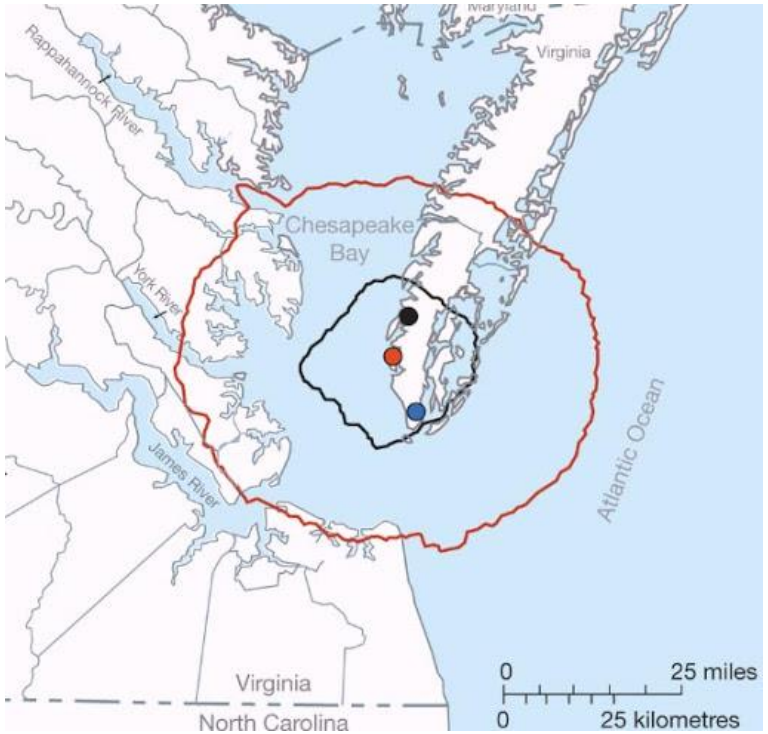

- 85 km in diameter, complex crater
- Formed 35.4 Ma into a sedimentary target

Highlight: Carbonate-bearing impactite

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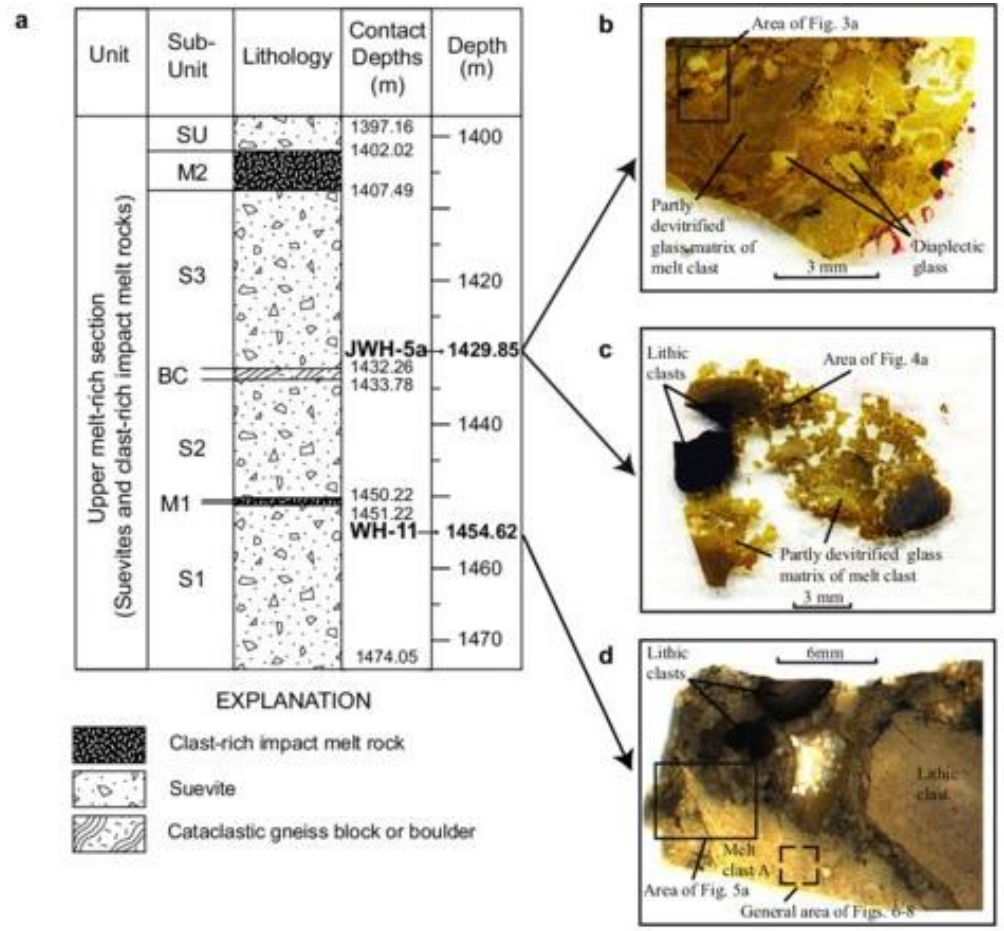
Sampling sites



- Sampling provided from drill core Eyreville B
- 2 samples, 20 g in mass each
- Samples represent suevite and melt rock

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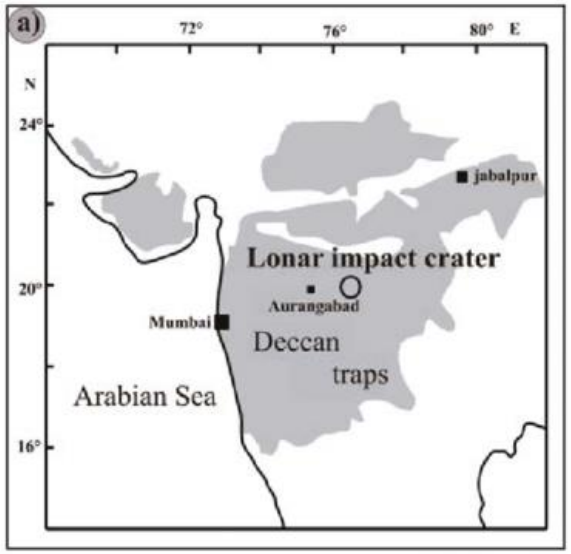

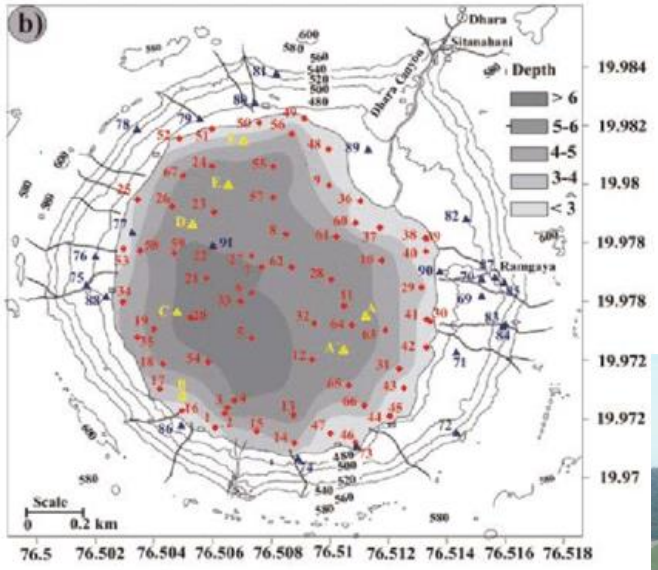

- Simple (1.9 km diameter) crater
- Formed at 520-570 ka
- Into 65 Ma Deccan Traps, tholeiite basalt
- Now infilled with lake of alkaline pH.

Highlight: Impact melts in basaltic target + hydrothermal activity

PTAL terrestrial analogue sites overview

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Chesapeake Bay

Lonar

Vargeao Dome

Samples

Increasing degree of shock

- 3 samples, 54-336 g in mass,
- Represent target basalt, highly shocked basalt and impact melt,
- Target rock slighty weathered,
- Vesicles of impact melt filled with alteration minerals.

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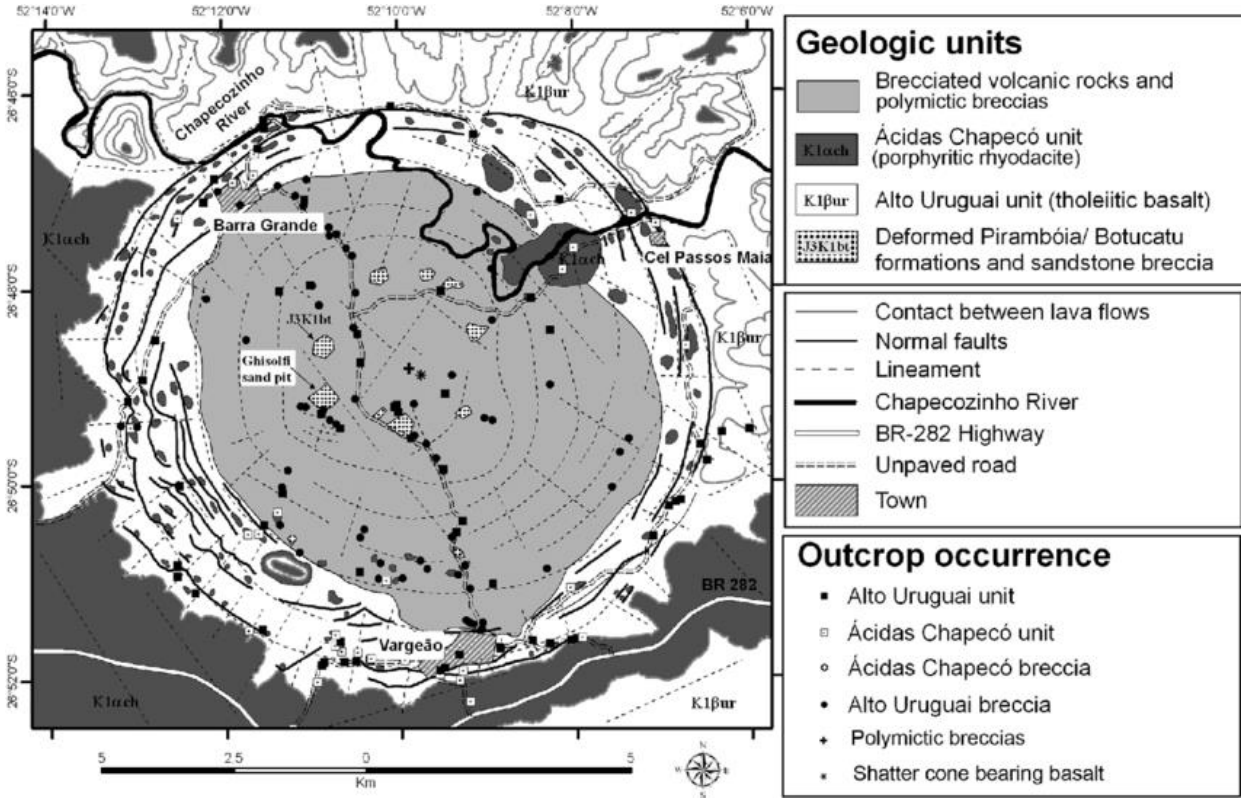

- A complex impact crater (12.4 km in d), formed 123Ma, in late Cretaceous.
- Formed in lavas and sandstones of the Parana Basin, Brazil.

Highlight: Impactites in basaltic target

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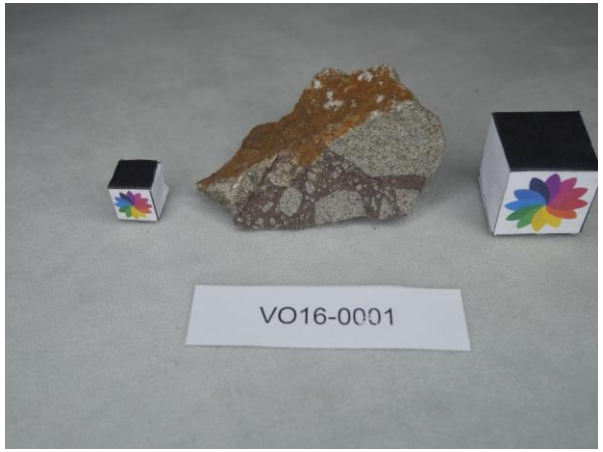
Sampling sites



- 4 samples, 130-260 g in mass
- Samples represent target basalt and polymict breccias of various sorts
- Contain alteration minerals: oxides, saponite, kaolinite

PTAL terrestrial analogue samples inventory

The final list of terrestrial analogues includes a total of 106 samples, which were organized in 15 different groups:

Group 1: Iceland (16 samples)

Iceland			Sampled by	Site	Coordinates	Weight
Reykjanes	HB	IS16-0001	DV	Haleyjabunga	N63 49 01.7 W22 39 03.1	355,77g
Reykjanes	HB	IS16-0002	DV	Haleyjabunga	N63 49 01.7 W22 39 03.1	472,77g
Near Stapafell	LF	IS16-0003	DV	Lagafell	N63 53 05.2 W22 32 10.8	251,81g
Near Stapafell	LF	IS16-0004	DV	Lagafell	N63 52 56.4 W22 32 32.3	618,04g
Near Stapafell	LF	IS16-0005	DV	Lagafell	N63 52 50.0 W22 32 24.6	647,80g
Stapafell	SF	IS16-0006	DV	Stapafell	N63 54 19.9 W22 31 58.0	415,23g
Stapafell	SF	IS16-0007	DV	Stapafell	N63 54 19.9 W22 31 58.0	331,42g
Stapafell	SF	IS16-0008	DV	Stapafell	N63 54 19.9 W22 31 58.0	163,31g
Stapafell	SF	IS16-0009	DV	Stapafell	N63 54 15.5 W22 31 52.0	345,86g
Krysuvik	SE	IS16-0010	DV	Seltun	N63 53 44.9 W22 03 09.2	77,18g
Krysuvik	SE	IS16-0011	DV	Seltun	N63 53 44.9 W22 03 09.2	218,79g
Krysuvik	SE	IS16-0012	DV	Seltun	N63 53 44.9 W22 03 09.2	288,43g
Reykjanes	HB	IS16-0013	DV	Haleyjabunga	N63 48 58.3 W22 39 38.8	318,22g
Reykjanes	RE	IS16-0014	DV	Reykjanes	N63 49 09.1 W22 40 55.9	187,59g
Grindavik	VH	IS16-0015	DV	Vatnsheidi	N63 51 48.5 W22 24 11.7	276,05g
Grindavik	VH	IS16-0016	DV	Vatnsheidi	N63 51 43.9 W22 24 22.6	296,80g

Group 2: Scotland (1 sample)

Scotland			Sampled by	Site	Coordinates	Weight
Rum	RU	RU16-0001	Dougal Jerram			158g

Group 3: Antarctica (1 sample)

Antartica			Sampled by	Site	Coordinates	Weight
Dry Vallies	DV	DV16-0001	Dougal Jerram			358g

Group 4: Canary Islands - Grand Canary (9 samples)

Grand Canary	Sample place #	Sample #	Sampled by	Site	Coordinates	Weight
Agaete	AG	AG16-0001	**DHST**	Agaete	N28.05.50.4 W015.41.50.9	764 g
Punta Camello	TO	TO16-0001	**DHST**	Arucas	N28.09.08.1 W 015.31.31.9	350 g
Bc.Tamaraceite	BT	BT16-0001	**DHST**		N28.07.14.0 W 015.27.30.0	130 g
Bc.Tamaraceite	BT	BT16-0002	**DHST**		N28.07.14.0 W 015.27.30.0	120 g
Pica Bandama	CB	CB16-0001	**DHST**	Bandama	N28.02.30.0 W015. 27.45.0	110 g
Fuente de Az.	FA	FA16-0001	**DHST**	Azulejos	N27.55.26.1 W 015.43.40.8	180 g
Fuente de Az.	FA	FA16-0002	**DHST**	Azulejos	N27.55.26.1 W 015.43.40.8	283 g
Fuente de Az.	FA	FA16-0003	**DHST**	Azulejos	N27.55.26.1 W 015.43.40.8	265 g
Roque Nublo	RN	RN16-0001	**VT**	Roque Nublo	N 27.54.02.7 W015.28.12.3	389g

Group 5: Canary Islands-Tenerife (9 samples)

Tenerife	Sample place #	Sample #	Sampled by	Site	Coordinates	Weight
Mna. Reventada	MR	MR16-0001	**DHS**	Mna. Reventada	N28.16.20.7 W016.43.43.4	652 g
Mna. Reventada	MR	MR16-0002	DHS	Mna. Reventada	N28.16.20.7 W016.43.43.4	450 g
Adeje	AD	AD16-0001	**DHS**	Adeje	N28.06.50.7 W016.44.00.1	438 g
Mna. Amarilla	AM	AM16-0001	DHS	Mna. Amarilla	N28.00.34.4 W016.38.14.4	155 g
Mna. Amarilla	AM	AM16-0002	**DHS**	Mna. Amarilla	N28.00.34.4 W016.38.14.4	490 g
Los Azulejos	TF	TF16 -0002	**FT**	Los Azulejos	N28 13 07.67, W 16.37.40.39	61 g
Los Azulejos	TF	TF16 -0028	**FT**	Los Azulejos	N28 13 07.67, W 16.37.40.39	173 g
Los Azulejos	TF	TF16-0059	**FT**	Los Azulejos	N28 13 07.67, W 16.37.40.39	167 g
Los Azulejos	TF	TF16-0066	**FT**	Los Azulejos	N28 13 07.67, W 16.37.40.39	66 g

PTAL terrestrial analogue samples inventory

Group 6: Norway – Oslo Rift (3 samples)

Oslo Rift		Sample #	Sampled by	Site	Coordinates	Weight
Ullernåsen	UL	UL16-0001	**D**	Gregers Gramsvei	N59.56.13.7 E010.38.47.9	866 g
Brattåsen	BR	BR16-0001	**D**	Brattåsen,Vestby	N59.35.44.3 E010.40.41.9	1022g
Brattåsen	BR	BR16-0002	**D**	Brattåsen,Vestby	N59.35.44.6 E010.40.57.8	1282g

Group 7: Norway – Leka (17 samples)

Leka		Sample #	Sampled by	Site	Coordinates	Weight
Leka	LA	LE16-0001	**DV**	Lauvhatten	N65.06.16.3 E011.41.44.9	446g
Leka	LA	LE16-0002	**DV**	Lauvhatten	N65.06.20.4 E011.41.18.7	962g
Leka	LA	LE16-0003	**DV**	Lauvhatten	N65.06.20.4 E011.41.18.7	478g
Leka	SK	LE16-0004	**DV**	At Skråen road	N65.06.35.5 E011.40.18.6	764g
Leka	ST	LE16-0005	**DV**	At Steinfjellet	N65.06.16.0 E011.36.29.0	550g
Leka	ST	LE16-0006	**DV**	At Steinfjellet	N65.06.16.0 E011.36.29.0	493g
Leka	ST	LE16-0007	**DV**	At Steinfjellet	N65.06.16.0 E011.36.29.0	84g
Leka	PV	LE16-0008	**DV**	At Pavillion	N65.06.17.5 E011.37.17.6	415g
Leka	AU	LE16-0009	**DV**	Aunkollen	N65.05.07.8 E011.35.05.8	548g
Leka	AU	LE16-0010	**DV**	Aunkollen	N65.05.07.8 E011.35.05.8	495g
Leka	AU	LE16-0011	**DV**	Aunkollen	N65.05.07.8 E011.35.05.8	371g
Leka	KV	LE16-0012	**DV**	Kvaløy	N65.06.58.2 E011.39.24.2	411g
Leka	MA	LE16-0013	**DV**	Madsøy	N65.02.32.6 E011.40.33.1	496g
Leka	SO	LE16-0014	**DV**	Solsem	N65.02.46.4 E011.32.58.2	314g+227g
Leka	SO	LE16-0015	**DV**	Solsemhola	N65.03.37.2 E011.34.11.7	168g
Leka	MO	LE16-0016	**DV**	Moho	N65.05.53.5 E011.39.54.0	890g
Leka	MO	LE16-0017	**DV**	Moho	N65.05.53.5 E011.39.54.0	876g

Group 8: Granby tuff (4 samples)

Granby Tuff		Sample #	Sampled by	Site	Coordinates	Weight
Granby Tuff	GR	GR-0001	Agata	Scenic View	42.254528 N 72.621361 W	86 g
	GR	GR-0002	Agata	Scenic View	42.254528 N 72.621361 W	118 g
	GR	GR-0003	Agata	Scenic View	42.254528 N 72.621361 W	430 g
	GR	GR-0005	Agata	Scenic View	42.254528 N 72.621361 W	48 g

Group 9: Otago (5 samples)

Otago			Sampled by	Site	Coordinates	Weight
Otago	OT	OT-001	Agata	Blue Spur conglomerate	169° 40.60821'E,45° 52.66415'S	520 g
Otago	OT	OT-002	Agata	Blue Spur conglomerate	169° 40.60821'E,45° 52.66415'S	260 g
Otago	OT	OT-003	Agata	Blue Spur conglomerate	169° 40.60821'E,45° 52.66415'S	310 g
Otago	OT	OT-004	Agata	Blue Spur conglomerate	169° 40.60821'E,45° 52.66415'S	330 g
Otago	OT	OT-005	Agata	Blue Spur conglomerate	169° 40.60821'E,45° 52.66415'S	230 g

Group 10: Spain mainland – Jaroso Ravine (3 samples)

Jaroso Ravine		Sample #	Sampled by	Site	Coordinates	Weight
Jaroso Ravine	JA	JA08-501	**CR**		N37.18.11.4 W 1.45.19.3	17g
Jaroso Ravine	JA	JA08-502	**CR**		N37.18.17.6 W 1.45.36.6	28g
Jaroso Ravine	JA	JA08-503	**CR**		N37.18.05.4 W1.45.09.6	48g

Group 11: Spain mainland – Rio Tinto (3 samples)

Rio Tinto		Sample #	Sampled by	Site	Coordinates	Weight
Rio Tinto	RT	RT03-501	**CR**		N37.43.32.4 W6.33.19.0	136g
Rio Tinto	RT	RT03-502	**CR**		N37.43.19.5 W6.33.04.5	13g
Rio Tinto	RT	RT03-503	**CR**		N37.43.30.5 W 6.33.29.7	26g

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Group 12: USA (26 samples)

USA			Sampled by	Site	Coordinates	Weight
John Day Valley	FO	JD16-0001	D	Foree	N44.65.07.70 W119.63.79.27	260,89g
John Day Valley	FO	JD16-0002	D	Foree	N44.65.07.70 W119.63.79.27	209,58g
John Day Valley	PG	JD16-0003	D	Picture Gorge	N44.53.05.70 W119.63.50.80	233,18g
John Day Valley	PG	JD16-0004	D	Picture Gorge	N44.53.05.70 W119.63.50.80	294,95g
John Day Valley	PG	JD16-0005	D	Picture Gorge	N44.53.05.70 W119.63.50.80	358,20g
John Day Valley	PG	JD16-0006	D	Picture Gorge	N44.51.20.65 W119.62.35.95	195,53g
John Day Valley	PG	JD16-0007	D	Picture Gorge	N44.51.20.65 W119.62.35.95	276,72g
John Day Valley	MB	JD16-0008	D	Mascall Basin	N44.50.30.3 W119.62.49.8	130,27g
John Day Valley	MB	JD16-0009	D	Mascall Basin	N44.50.30.3 W119.62.49.8	251,07g
Painted Hills	BG	JD16-0010	D	Painted Hills	N44.65.32.2 W120.28.37.3	194,31g
Painted Hills	BG	JD16-0011	D	Painted Hills	N44.65.32.2 W120.28.37.3	603,53g
Painted Hills	BG	JD16-0012	D	Painted Hills	N44.65.03.24 W120.28.40.14	144,69g
Painted Hills	BG	JD16.0013	D	Painted Hills	1102016	244,64g
Painted Hills	BG	JD16-0014	D	Painted Hills	N44.65.27.81 W120.28.43.38	297,48g
Painted Hills	BG	JD16-0015	D	Painted Hills	N44.65.27.81 W120.28.43.38	154,92g
Clarno	HS	JD16-0016	D	Hancock Station	N44.92.21.7 W120.43.32.4	212,14g
Clarno	HS	JD16-0017	D	Hancock Station	N44.92.21.7 W120.43.32.4	206,63g
Clarno	HS	JD16-0018	D	Hancock Station	N44.92.23.6 W120.43.34.7	320,01g
Clarno	HS	JD16-0019	D	Hancock Station	N44.92.23.6 W120.43.34.7	349,90g
Painted Hills	PH r	JD16-0020	D	Painted Hills	N44.38.00.9 W120.13.10.6(WGS84)	332,44g
Painted Hills	PH r	JD16-0021	D	Painted Hills	N44.38.00.9 W120.13.10.6(WGS84)	423,27g
Painted Hills	PH l	JD16-0022	D	Painted Hills	N44.38.22.8 W120.16.51.4(WGS84)	206,07g
Painted Hills	PH l	JD16-0023	D	Painted Hills	N44.38.22.8 W120.16.51.4(WGS84)	213,62g
Painted Hills	PH l	JD16-0024	D	Painted Hills	N44.38.22.8 W120.16.51.4(WGS84)	325,61g

Group 13: Brazil (4 samples)

Brazil			Sampled by	Site	Coordinates	Weight
Vista Allegre	VA	VA16-0001	Alvaro Crosta			134,45g
Vargeao Dome	VD	VO16-0001	Alvaro Crosta			140,45g
Vargeao Dome	VD	VO16-0002	Alvaro Crosta			133,10g
Vargeao Dome	VD	VO16-0003	Alvaro Crosta			257,0g

Group 14: Lonar crater (3 samples)

Lonar Crater			Sampled by	Site	Coordinates	Weight
India	OT	OT-001	Agata	Lonar Crater	76°30.30'E,19°59'N	330 g
India	OT	OT-002	Agata	Lonar Crater	76°30.30'E,19°59'N	200 g
India	OT	OT-003	Agata	Lonar Crater	76°30.30'E,19°59'N	54 g

Group 15: Impact melt rocks (4 samples)

Impact melt rocks	Sample place #	Sample #	Sampled by	Site	Coordinates	Weight
Gardnos	GN	GN16-0001	E.Kalleson	Dokkelva		100 g
Vredefort	VR	VR16-0021	H.Dypvik	Leeukop Qu		130 g
Chesapeake Bay	WH	WH16-0005	Wright Horton	Eyreville B core		19,8 g
		WH16-0014	Wright Horton	Eyreville B core		21,4 g

Detailed information about the selected terrestrial analogue site and the collected samples can be found in a dedicated manuscript:

H. Dypvik et al., *The Planetary Terrestrial Analogues Library (PTAL) - An Exclusive Lithological Selection of Possible Martian Earth Analogues.* Planetary and Space Science (open access). https://doi.org/10.1016/j.pss.2021.105339

Physical access to the samples

- We are happy **to loan the samples for further characterizations, laboratory experiments, instrument testing, operation simulations**, and others.
- Samples are currently stored at the University of Oslo and curated by us, before they will be moved to their final curation facility place, where the samples remain as witness samples. At the moment, the majority of samples are secured in amounts sufficient **to support loans up to ~2-5g** or even destructive procedures. Some samples exist in low masses only and for those we are able to support loan requests in a range of hundred micrograms of rock. Keep in mind, however, that **apart from cut rock pieces, we can also discuss loan of coarse or fine powders**, fully representative for the samples that were used for database building and are kept as a part of collection now.
- Additionally, we are happy to consider **loans of our witness samples for non-destructive and non-invasive purposes** (imaging, scanning etc.) and are always willing to share coordinates of our sampling (which you can also find in the PTAL database), so that further collection of material is possible if you need it.
- **Please contact Prof. Stephanie Werner** (stephanie.werner (at) geo.uio.no) or **Dr. Agata Krzesinska** (a.m.krzesinska (at) geo.uio.no) to ask for loan possibilities. Do not hesitate to contact us if you would like to know more about specific samples or need further advice on how analogous the samples are for your specific aims.

PTAL

Planetary Terrestrial Analogues Library

Visit our website ➡

- The PTAL webpage, that provides general information about the project. https://ptal.eu/

- PTAL online platform, that give access to terrestrial analogues info and data. https://erica.uva.es/PTAL/

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