

DATA PAPER

Geochemical Sourcing of New Zealand Obsidians by Portable X-Ray Fluorescence from 2011 to 2018

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This dataset includes 4,582 obsidian artefacts matched to their natural geological source from 45 archaeological sites in New Zealand (Aotearoa). It is a compilation of a number of independent projects conducted in the laboratories of the University of Auckland and University of Otago from 2011 to 2018 [1–13]. It combines previously published studies [3, 5–13], an MA thesis [1], a BA(Hons) dissertation [2], a site report [4], and other previously unpublished primary data. The dataset has high reuse potential for future non-destructive studies of artefacts and social network analyses.

Keywords: obsidian; geochemical sourcing; portable X-ray fluorescence (pXRF); New Zealand (Aotearoa); Polynesia

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(1) Overview

Context

Spatial coverage

Description: New Zealand

Northern boundary: –34.1194851

Southern boundary: –48.9015311

Eastern boundary: 179.5011487

Western boundary: 165.1523805

Temporal coverage

Collections include artefacts that may date from the initial settlement by the ancestors of Māori around AD 1280 through the period of regular contact with Europeans after AD 1850.

(2) Methods

Each artefact was assessed mid-z elements (Nb, Rb, Y, Zr, Sr) and other elements (Fe, Mg) using a pXRF and then matched to a geochemically distinct natural source of obsidian. Geographically ambiguous source assignments, such as assignment to a general volcanic zone, were not included. We note that out of the 15 known geochemically distinct natural sources of New Zealand obsidian [12], only 13 have been identified in archaeological collections.

Steps

The two university laboratories that produced this data each specified procedures in a series of publications. The specific lab protocols and machines used evolved over this period and so readers are directed to original studies for a fuller description. Examples of methods for Bruker pXRF, a type used in both laboratories, is summarised below.

University of Auckland

XRF analysis was carried out in the Roger Green Archaeological Laboratories, School of Social Sciences, University of Auckland, using either a Innov-X Alpha (see methods described in [12]) or a Bruker Tracer III SD portable X-ray Fluorescence (pXRF) analyser (see methods described in [11]).

The Bruker Tracer III SD instrument employs an X-ray tube with an Rh target and a 10mm² silicon drift detector (SDD), with a typical resolution of 145eV at 100,000cps. The X-ray tube was operated with a setting of 40 keV at 10.7μA, through a window composed of 12mil Al and 1mil Ti filters (Bruker’s Yellow filter). Samples were analysed in an air path for 60 seconds. Each specimen was analysed twice on a different portion of its surface area to check for consistency and the values were averaged.

A total of 12 elements were quantified (K, Ca, Ti, Mn, Fe, Zn, Th, Rb, Sr, Y, Zr, Nb). Concentrations were calculated as parts-per-million (ppm) using Bruker's S1CalProcess (ver. 2.2.33) software. A set of 24 reference specimens are used for this calibration, including 18 international standards (AGV-2a, ANU-2000, GA, GSP-2, JA-1, JA-2, JA-3, JF-2, JG-1a, JG-2, JG-3, JR-1, JR-2, JR-3, NIM-S, NIM-G, NIST-278, QLO-1b) and six New Zealand obsidian specimens from the Anthropology Laboratory reference collection that were analysed using Wavelength Dispersive X-ray Fluorescence (AU-17.59, AU-29.16, AU-32.1, AU-7.21, AU-9.3, AU-9.5). Reference standard NIST-278 is routinely analysed to check for consistency.

University of Otago

XRF analysis was carried out in the archaeology laboratories of the University of Otago using a BrukerAXS™ pXRF. All samples were shot using optimal settings for 'mid-z' trace elements (Rb, Sr, Y, Zr, and Nb), specifically 40kv and 8 or 25 microamps at a 300 second live time and with a filter (12milAl + 1milTi + 6milCu, or what the manufacture refers to as the 'green' filter). To examine lighter elements (Si, Ti, Al, Fe, Mn, Mg, Ca, Na, K), a second protocol was used that engaged the Bruker pXRF's

vacuum, with the beam set to 15kv and 45 microamps, but with no filter. For both settings, laboratory specific quantification protocols were created and applied. Linear regressions were based on nine pelletized international standards each shot three times for each of the two setting. Green filter linear regressions were improved by applying Speakman's OB40 calibration to raw counts before the lab specific linear regression. A pelletized USGS basalt standard (BHVO-2) was run alongside samples as a quality check of precision and accuracy, with an additional second standard (SRM-278) run on the vacuum setting to check the pXRF performance over a range of values (ppm).

Sampling strategy

See original studies for details on collections and sampling strategies.

Quality Control

The two university laboratories produced quality control data based on international geological standards. The specific quality evaluations vary from study to study and so readers are directed to original studies for a fuller description. Examples of quality check results for Bruker pXRF, a type used in both laboratories, is summarised below:

University of Auckland: Comparison of calibrated results to accepted values for reference Standard NIST-278. All values are in parts-per-million (ppm). [4]

	K	Ca	Ti	Mn	Fe	Zn	Th	Rb	Sr	Y	Zr	Nb
Accepted value	34534	7004	1499	403	14269	54	12	128	64	39	290	18
pXRF Mean (n = 10)	34898	7221	1507	399	15113	53	13	131	65	40	288	17
<i>Standard deviation</i>	633	196	85	14	113	4.1	0.3	2.4	2	0.2	1.1	1.1

University of Otago: Comparison of calibrated results to accepted values for several reference samples. All values are in parts-per-million (ppm). Overall, values come close to published values and results for each setting produce comparable results. The exception is Th, which for this standard is near the limit of detection (LOD).

BHVO-2	Mn	Fe	Zn	Th	Rb	Sr	Y	Zr	Nb
USGS recommended	1290	78144	103	1.2	9.8	389	26	172	18
Otago n = 43 (8 microamps)	1270	68332	116	2.2	10	378	24	159	16
sd	174	1599	41	3.2	2	18	2	7	2
Otago n = 7 (25 microamps)	1280	77388	101	0.6	12	371	25	164	17
sd	101	6117	11	2.2	2	28	2	11	2
NIST SRM-278	Mn	Fe	Zn	Th	Rb	Sr	Y	Zr	Nb
NIST recommended	403	14269	n.r.	12.4	127.5	63.5	n.r.	n.r.	n.r.
sd	2	140		0.3	0.3	0.1			
Otago Lab, N = 3 (25 microamps)	419	13570	49	11.7	131	73	39	284	18
sd	276	190	7	0.4	4	1	1	2	1

As a check on accuracy on obsidians, an Otago lab standard Mayor Island Obsidian (AL380) is shown below as compared with published results from University of Auckland:

Mayor Island Obsidian	Mn	Fe	Zn	Th	Rb	Sr	Y	Zr	Nb
Sheppard et al. (2011), pXRF	871	36942	194.2	n.r.	146.5	LOD	n.r.	1146.9	n.r.
sd	113.6	2949.8	24		16.9			131.3	
AL380 Otago, XRF (25 microamps, solid)	718	30578	164	19.9	149	LOD	119	1184	101
sd	61	353	11	2.3	2		5	7	3

Constraints

None.

(3) Dataset description**Object name**

Sourced Obsidian Artefacts, New Zealand, 2011–18.

There are two files in the Digital Archaeological Record,

(1) **Master_list_NZ_obsidians_2011_2018.csv** and

(2) **Supporting_Data_NZ_obsidians_2011_2018.zip**.

The master list gives source assignments by site.

The supporting data lists any ppm and/or lithic technology information available and includes 28 files.

Data type

Most are secondary data; previously unpublished primary data referenced as “this study.”

Format names and versions

csv, pdf

Creation dates

The data was created between 01/01/2011 and 09/18/2018.

Dataset Creators

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Language

English

License

CC-BY 2.0

Repository location

Geochemical Sourcing of New Zealand Obsidians by Portable X-Ray Fluorescence from 2011 to 2018. Mark McCoy. 2018 (tDAR id: 446766); DOI: <https://doi.org/10.6067/XCV8C250CS>.

Geochemical Sourcing of New Zealand Obsidians by Portable X-Ray Fluorescence from 2011 to 2018 (ppm/tech). Mark McCoy. 2018 (tDAR id: 446767); DOI: <https://doi.org/10.6067/XCV87947N7>

Publication date

The dataset is available on the Digital Archaeological Record (tDAR) repository.

(4) Reuse potential

Obsidian sourcing studies have become more commonplace since the widespread adoption of pXRF in archaeology. This dataset is the first national scale summary of artefacts definitively matched to source. It has excellent potential for future study regarding Māori culture history, social network analyses, and methodological development in the application of pXRF.

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Competing Interests

The authors have no competing interests to declare.

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