



**CANADIAN
CENTRE *for*
ISOTOPIC
MICROANALYSIS**

CCIM-SIMS

MICROBEAM REFERENCE MATERIAL CHEMISTRY: CALCITE S0161, DATA RELEASE 06-2024

CCIM RESEARCH REPORT 24-01

Stern, R.A.

Canadian Centre for Isotopic Microanalysis, Department of Earth and Atmospheric Sciences, University of Alberta, Canada T6G 2R3

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SAMPLE INFORMATION

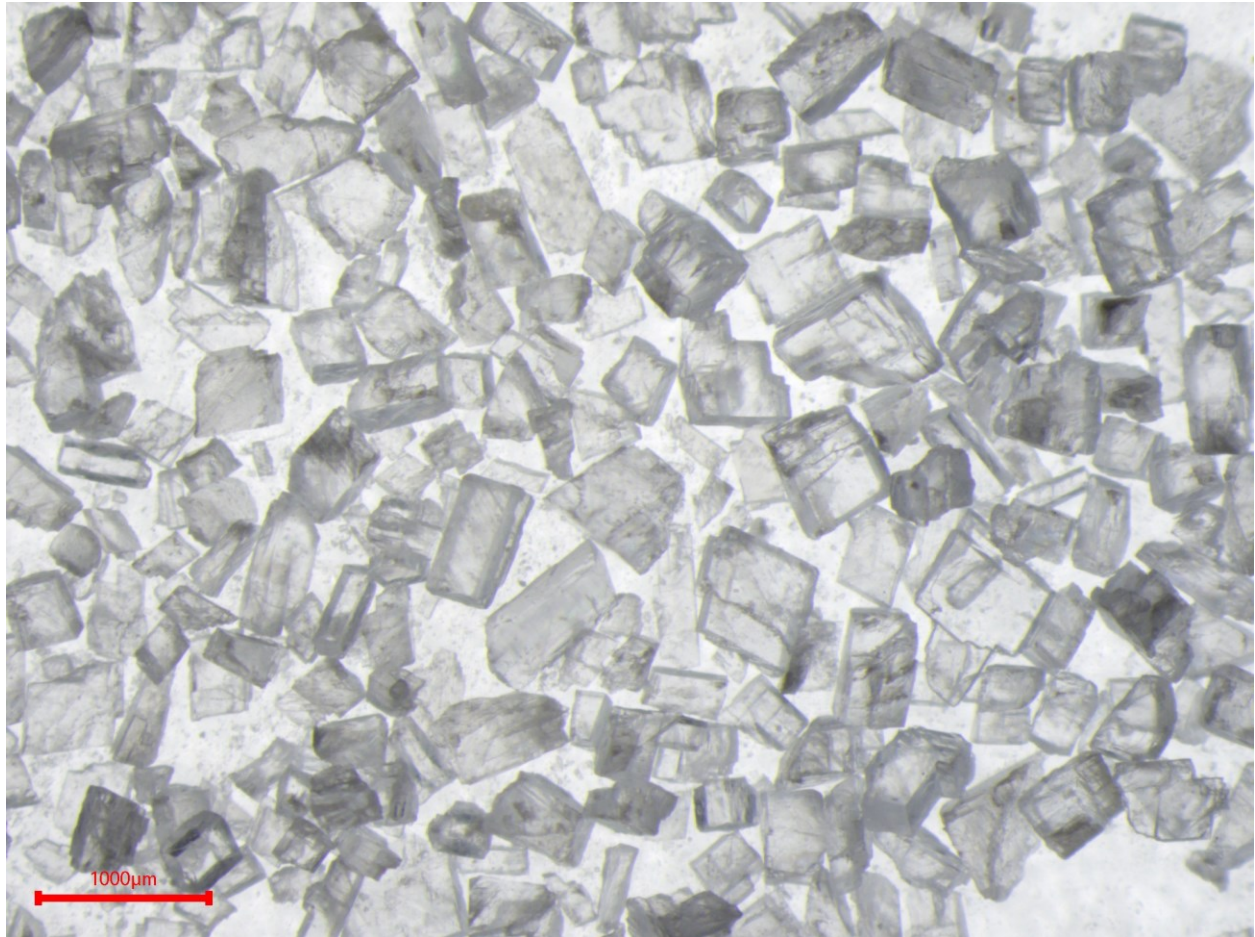
Date of validity	2024-06-12
CCIM root sample number	S0161
CCIM sub-sample number(s)	
Alias (CCIM or external) sample names	
Isotope systems calibrated with this RM*	18O-16O, 13C-12C
Trace elements calibrated with this RM*	
Material type	mineral
Mineral name	calcite
Other material type	
Material composition (basic)	CaCO ₃
Material original growth context if known	from multi-mineral rock
Originating rock type	calc-silicate xenolith
Co-occurring minerals (if relevant as RM)	
Co-occurring CCIM RM sample numbers	
Colour	
Translucence	clear, cloudy
Source of material	T. Chacko, University of Alberta
Originating geographic location	Cascade Slide, NY, USA
Originating geological information	granulite-facies xenolith within Proterozoic anorthosite, Adirondack Mtns, USA (Valley and Essene, 1980)
Form of material in use as RM	many individual sub-samples/pieces, < 1mm
Form of material in reserve	<input checked="" type="checkbox"/> sub-samples, mm to cm size <input type="checkbox"/> original bulk/rock sample
Sub-sample available to qualified researchers	Yes

*see section "Reference Values Summary" for current numbers.

PLAIN LIGHT IMAGES

STEREO-MICROSCOPE

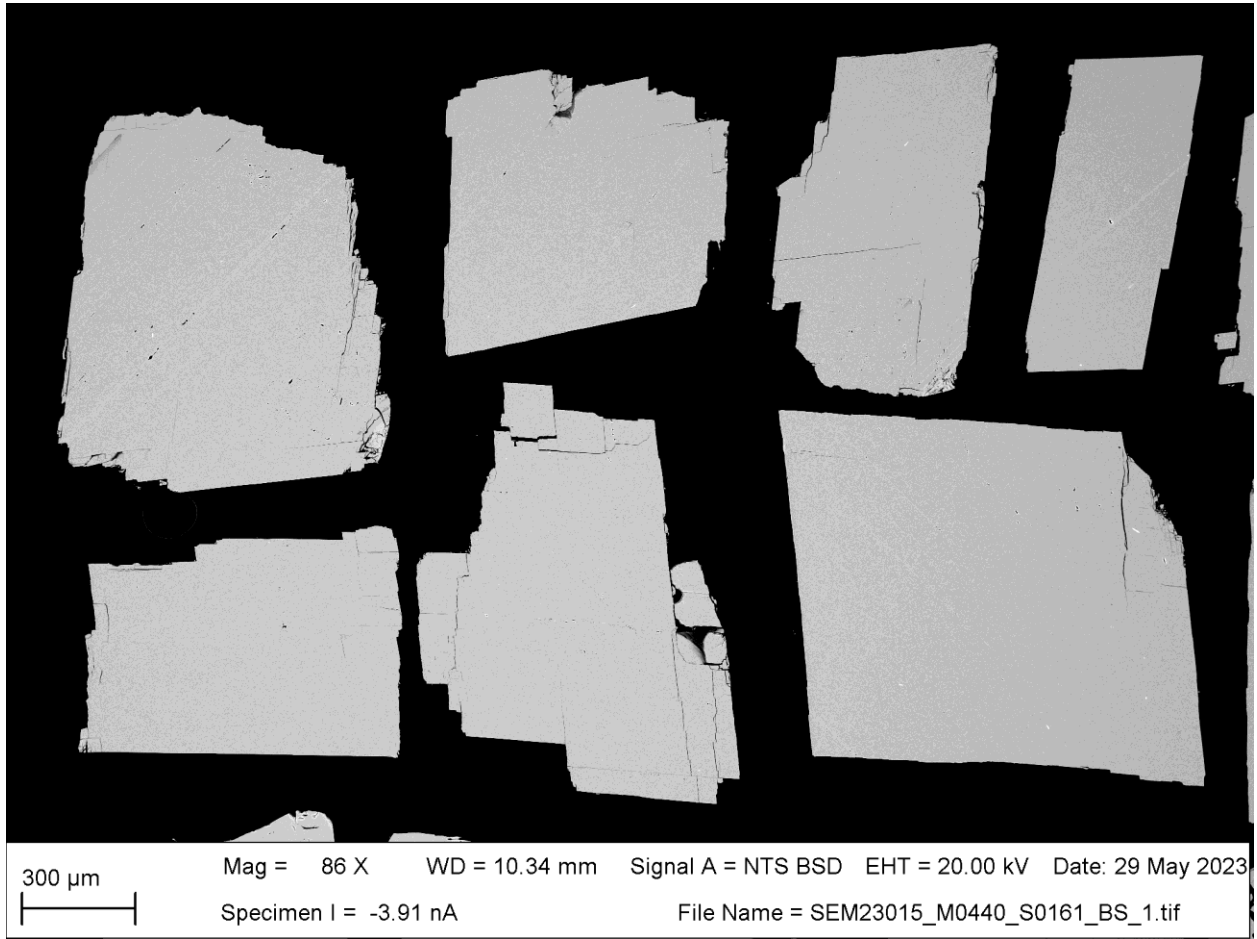
Figure 1: Representative sample of S0161 calcite in transmitted light.



SCANNING ELECTRON MICROSCOPY

BACKSCATTERED ELECTRONS(BSE)

Figure 2: Representative BSE image of S0161 calcite.



MAJOR AND TRACE ELEMENTS

ELECTRON PROBE MICROANALYSIS (EPMA)

Table 1: A set of major element abundance spot measurements on S0161 calcite. The RM has low to undetectable minor and trace element contents (Si, Fe, Sr, Mg, Mn).

Oxides										
	unit	SiO ₂	FeO	CaO	SrO	MgO	MnO	CO ₂		Total
N		14	14	14	14	14	14	14		
median	m/m %	0.00	0.00	55.08	0.00	0.11	0.00	43.22		98.41
s		0.01	0.03	0.36	0.01	0.14	0.02	0.28		
Cations										
	unit	Si	Fe	Ca	Sr	Mg	Mn	C		
median	formula #	0.0000	0.0000	0.9988	0.0000	0.0028	0.0000	0.9988		2.0004
Data from M. Whitehouse (2016, pers. comm.), via Univ of Copenhagen, Dept. of Geosciences and Natural Resource Mangement JEOL JXA-8200, WDS analysis										

ISOTOPES

GAS-SOURCE ISOTOPE RATIO MASS SPECTROMETRY

Table 2: Compilation of GS-IRMS C-isotope data for the RM S0161, with current reference values.

13C-12C								
Data set	Date	median $\delta^{13}\text{C}_{(\text{VPDB})}$ ‰	N	s ‰	sample mass mg	Laboratory	Source	Comments
1	2014-01-01	0.12	5	0.01		Laboratory for Stable Isotope Science, University of Western Ontario	this study	Gas Bench II and Delta XP MS (Thermo Finnigan), 90°C acid reaction
2	2018-05-01	0.04	6	0.05	0.6	Veizer Lab, University of Ottawa	this study	Gas Bench II and Delta XP MS(Thermo Finnigan), 25°C acid reaction
3	2022-05-12	0.06	5	0.05	0.5	Veizer Lab, University of Ottawa	this study	Gas Bench II and Delta XP MS(Thermo Finnigan), 25°C acid reaction
4	2021	0.22	10	0.11		Department of Geosciences, Stockholm University	M. Whitehouse, pers. comm (2018), and von Leeson et al., (2021)	Thermo-Finnigan GasBench II and CTC PAL autosampler, MAT253 MS; M. Whitehouse, pers. comm (2018), and von Leeson et al., (2021)
mean		0.11		0.08				
Current CCIM reference value	2024-06-03	0.11						average of all data sets

Table 3: Compilation of GS-IRMS O-isotope data for the RM S0161, with current reference values.

18O-16O									
Data set	Date	median $\delta^{18}\text{O}_{(\text{VSMOW})}$ ‰	median $\delta^{18}\text{O}_{(\text{VPDB})}$ ‰	N	s ‰	sample mass mg	Laboratory	Source	Comments
1	2014-01-01	25.35	-5.40	5	0.01		Longstaffe Lab, University of Western Ontario	this study	Gas Bench II and Delta XP MS (Thermo Finnigan), 90°C acid reaction
2	2018-05-01	25.31	-5.44		0.04	0.6	Veizer Lab, University of Ottawa	this study	Gas Bench II and Delta XP MS (Thermo Finnigan), 25°C acid reaction
3	2022-05-12	25.20	-5.55		0.04	0.5	Veizer Lab, University of Ottawa	this study	Gas Bench II and Delta XP MS (Thermo Finnigan), 25°C acid reaction
4	2021	25.12	-5.62	10	0.12		Department of Geosciences, Stockholm University	M. Whitehouse, pers. comm (2018), and von Leeson et al., (2021)	Thermo-Finnigan GasBench II and CTC PAL autosampler, MAT253 MS; M. Whitehouse, pers. comm (2018), and von Leeson et al., (2021)
mean		25.24	-5.50		0.11				
Current CCIM reference value	2024-06-03	25.31	-5.44						median of preferred data sets 1,2,3, and considering SIMS intercalibration with other calcite RMs, particularly IAEA-603

SECONDARY ION MASS SPECTROMETRY (CCIM)

Table 4 reports two representative SIMS sessions analyzing C- and O-isotopes on multiple fragments of calcite S0161 interspersed with analyses of calcite certified reference material IAEA-603 (Assonov et al., 2020). These data demonstrate that S0161 is isotopically homogeneous within analytical uncertainties at the 10 – 20 micron scale, with session standard deviations from multiple spots on multiple grains of ± 0.25 ‰ and ± 0.10 ‰ for $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$, respectively. The data also show that the C- and O-isotope reference values for S0161, when used for SIMS calcite standardization, yield values for IAEA-603 run as an unknown consistent with its certified numbers.

Table 4: Representative SIMS C- and O-isotope data on S0161 calcite.

		units	1	2
	Data set		1	2
	Instrument		CCIM IMS1280	CCIM IMS1280
	Session		IP21042	IP21046
	CCIM Mount #		M0399	M0400
	Primary beam		Cs+	Cs+
	Secondary ions		13C-, 12C-	18O-, 16O-
	Primary impact energy	keV	20	20
	probe diameter	x 10 ⁻⁶ m	15	15
	Mass resolution	m/ Δ m (10%)	2950, 1950	2250, 1950
	Multi-detectors		EM, L'2	H'2, L'2
S0161, calcite	# grains		6	6
	# spots		41	26
	Assumed reference value d18O(VSMOW)	1000* δ		25.31
	Assumed reference value d13C(VPDB)	1000* δ	0.11	
	session spot-spot standard deviation	‰	0.25	0.10
IAEA-603, calcite	# grains		38	26
	# spots		41	31
	session median d18O(VSMOW)	1000* δ		28.48
	session median d13C(VPDB)	1000* δ	2.38	
	session spot-spot standard deviation	‰	0.40	0.10
	Certified value	1000* δ	2.46 \pm 0.01	28.47 \pm 0.04

REFERENCE VALUES SUMMARY

Table 5: Calcite RM S0161 current reference values.

Isotope-chemical system	Current reference value	Unit	± estimate (same units as value)	Normalization
18O-16O	+25.31	1000• $\delta^{18}\text{O}$	0.10	VSMOW
18O-16O	-5.44	1000• $\delta^{18}\text{O}$	0.10	VPDB
13C-12C	+0.11	1000• $\delta^{13}\text{C}$	0.10	VPDB

DEFINITIONS AND TERMINOLOGY

For stable isotope terminology and normalizing values, the following sources were used:

Coplen et al. (2002)

Coplen (2011)

Brand et al. (2014)

Kim et al. (2015)

7. ACKNOWLEDGMENTS

T. Chacko is thanked for providing the source material. L. Otter is thanked for reviewing the text.

8. REFERENCES

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