Vulnerability of mineral collections to indoor environments – a synopsis

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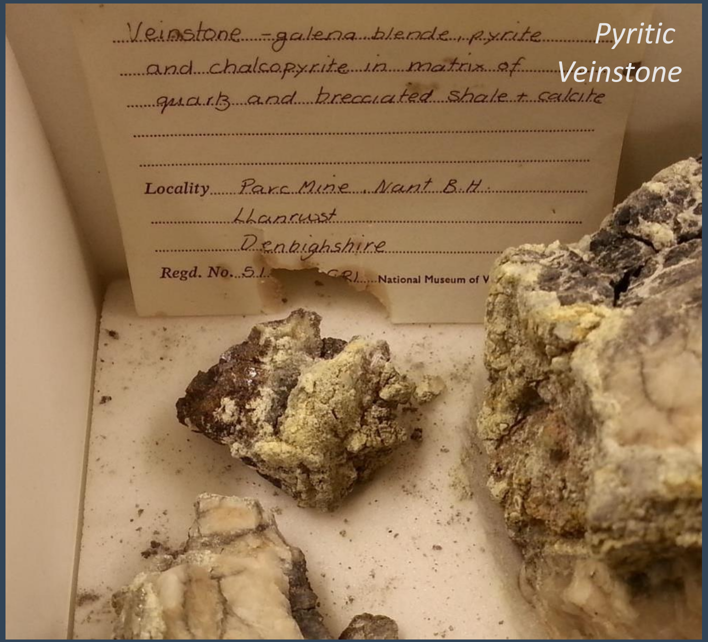
OR3D Digitise Dimension Design

BSRIA

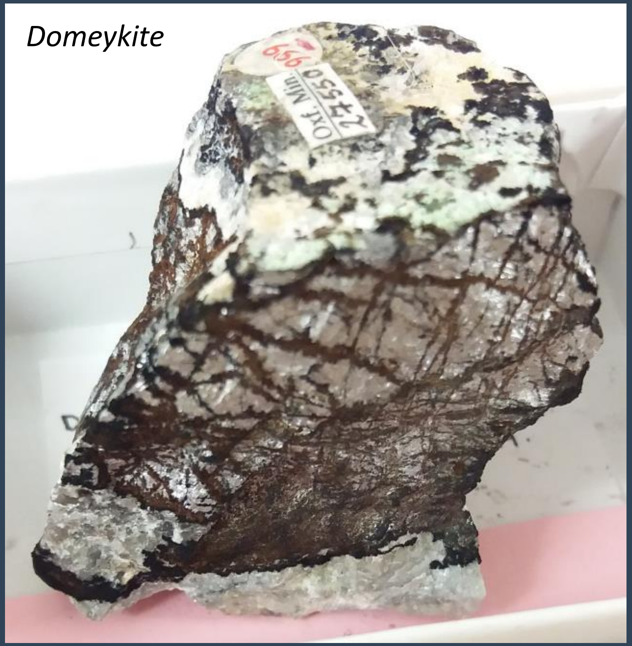
Mineral Deterioration

Cinnabar

Halite



Pyritic Veinstone



Domeykite

- manifest in a variety of ways:
  - colour change or loss
  - corrosion / oxidation
  - cracking
  - crumbling
  - dehydration / hydration
  - deliquescence
  - efflorescence
  - fracture
- largely considered as damage
  - negatively effects integrity, value, & use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Susceptibility

- governed by:
  1. ambient conditions
  2. physical & chemical properties
     - conditions favourable for stability
     - response / change to unfavourable conditions
- inherent, secondary property
- expression dependent on likelihood of exposure to an agent
- degree = likelihood x effect

"The state or fact of being likely or liable to be influenced or harmed by a particular thing"
– Oxford University Press 2021

the Systematic Display Gallery at the Natural History Museum, London

Susceptibility in Heritage Contexts

- ➢ determines which hazards pose deterioration risks*
- ➢ informs storage & display conditions*

10 Agents of Change**

- ➢ Incorrect Humidity
- ➢ Incorrect Temperature
- ➢ Light (vis & UV)
- ➢ Pollutants
- ➢ Physical Forces
- ➢ Water
- ➢ Fire
- ➢ Pests
- ➢ Criminals
- ➢ Dissociation

* Royce, Baars, & Cotterell 2021. *The Geological Curator*, 11 (5), 355-360.
** ICCROM (Pedersoli et al.) 2016. *A Guide to Risk Management of Cultural Heritage*, p. 27

the Field Museum, Chicago

the Indoor Environment

Parameters:

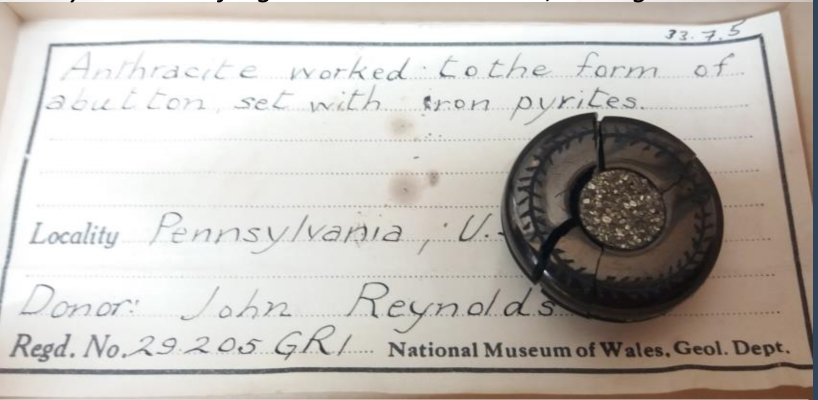
- -20-50°C
- 1-100% RH
- visible light & UV
- indoor pollutants: particulates, aerosols

Covers 'extremes' that could occur during:

- equipment & infrastructure failure
- unusual weather
- flooding
- localised heating by spotlights

as well as buildings without insulation or HVAC

Ruby on zoisite frogs – the Field Museum, Chicago



Marble specimen centre table – Ashmolean, Oxford

Mineral Susceptibility Database

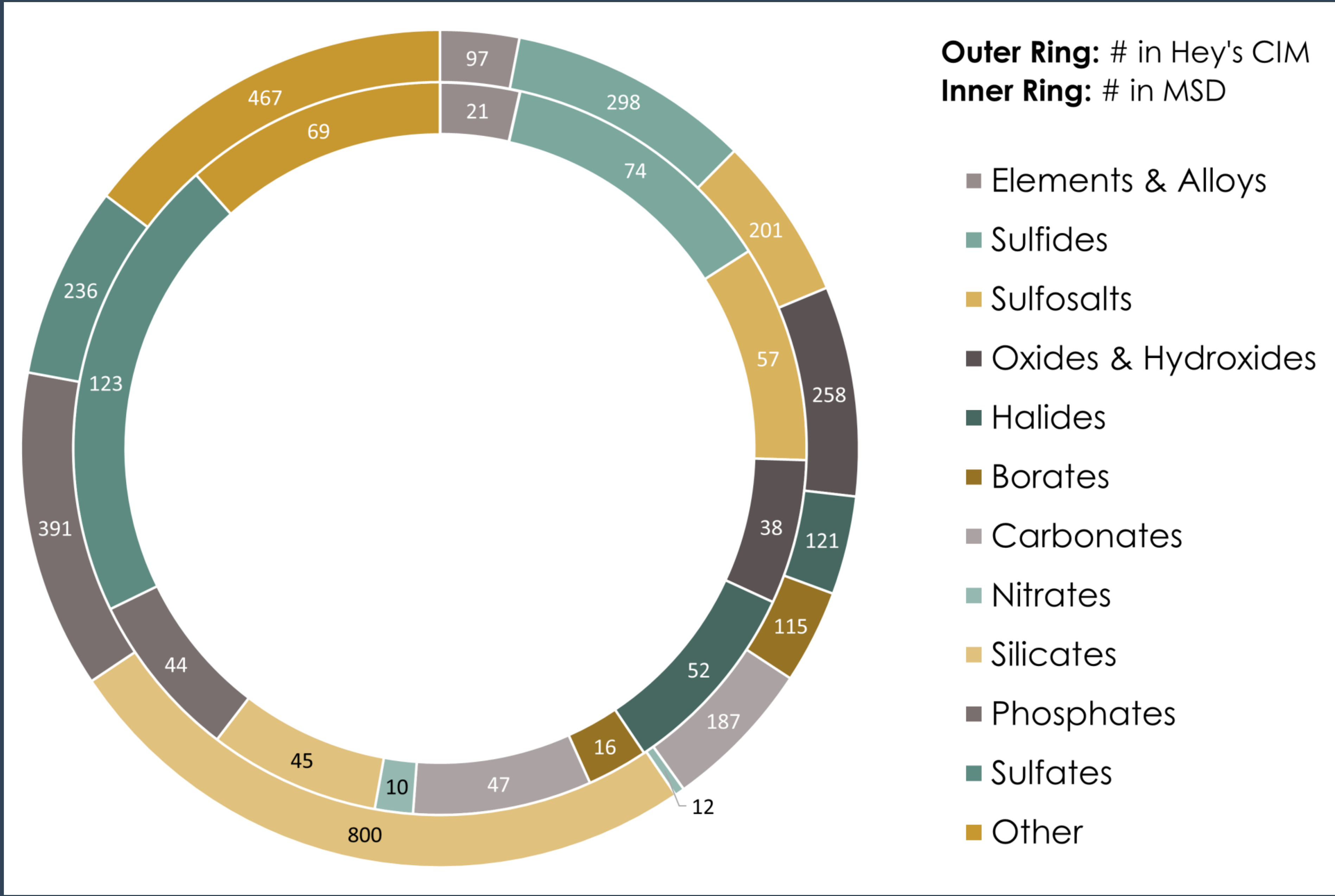
- Comprehensive resource for assessing conditions required by mineral objects & collections
- Consolidates current research from various scientific fields
- One freely accessible location
  - Improve access to reliable information

By being a repository of interdisciplinary research, the Database:

1. encourages informed decision making,
2. increases awareness of which disciplines & institutions are performing relevant research,
3. exposes additional research applications & opportunities,
4. advocates cross-disciplinary research & communication.

Facts & Figures

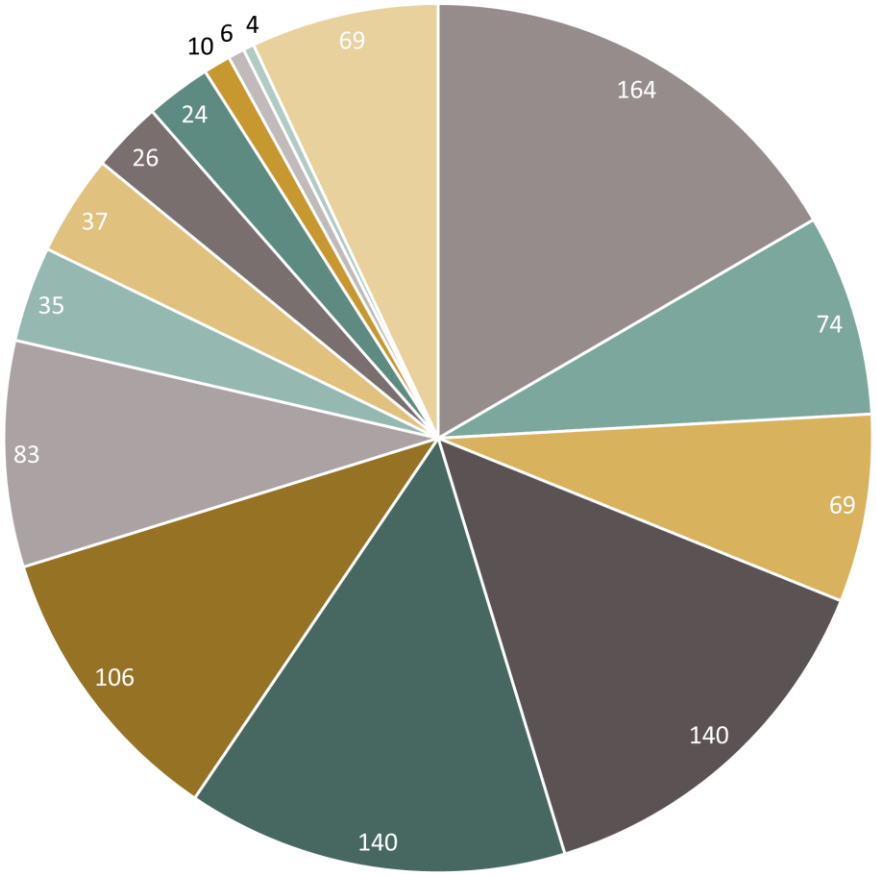
- 596 minerals
- 987 entries
- 10% of total mineral species
- 17% of species in Hey's CIM
- Some mineral groups better represented than others



Water Predominance

Entries: Agent of Change

Agent	#	%
Water	662	67
Pollutants	158	16
Light	134	14
Temperature	23	2
Oxygen	10	1



Response	Total	Percent (%)
Dehydration	164	17%
Hydration	74	8%
Photo-oxidation	69	7%
Oxidation	140	14%
Soluble - Water	139	14%
Soluble - Acid	105	11%
Deliquescence	83	8%
Hygroscopic	35	4%
Colour Change	36	4%
Porous	25	3%
Decomposition	24	2%
Efflorescence	10	1%
Structural Alteration	6	1%
Hydrolysis	4	0.4%
Other	69	7%

- MSD = reflection of published knowledge
  - Hydration & oxidation state changes are common & important reactions that occur under atmospheric conditions

- Is this a true reflection of reality?

MSD Aiding Future Research

Existing entries & references evidence:

- Knowledge gaps → research opportunities
  - Reaction types & details (i.e., parameters & products)
- Current research hotspots (e.g., sulfates → Martian research)
  - Institutions & individuals performing research

Hey Number	Mineral Name	Chemical Formula	Conditions	Response	Appearance	Alterations	References
8.5.2	calomel	$[Hg_2]^{2+}Cl_2$	light	disproportionation		to metallic mercury & mercuric chloride	Neiman et al. 2015
8.5.3	terlinguaite	Hg_2OCl	light	surfical photo-oxidation	yellow: olive green		Nassau 1992; King 1985
8.5.6	eglestonite	$([Hg^{1+}]_2)_3OCl_3(OH)$	light	surficial photo-oxidation	colour change: brown or darkens	mercury liberation	Nassau 1992; King 1985
8.6.2	chloraluminite	$AlCl_3 \cdot 6H_2O$	25C, > ~40% RH	deliquescence			Waller 1992
				hydrolysis			King 1985; Howie 1984
8.6.3	cadwaladerite	$AlCl(OH)_2 \cdot 4H_2O$		deliquescence			Waller 1992
8.7.1	fluocerite-(Ce)	$(Ce,La)F_3$	light	colour change	yellowish- or reddish-brown		O'Donoghue 1983
8.8.17	bideauxite	$Pb_2AgCl_3(F,OH)_2$	high light levels	colour change	pale lavender		Howie 1984
8.10.1	scacchite	$MnCl_2$	25C, > ~56% RH	deliquescence			Waller 1992
8.10.3	chloromanganokalite	K_4MnCl_6		deliquescence		decomposes easily	Waller 1992; O'Donoghue 1983
				efflorescence			Howie 1984
8.11.1	molysite	$FeCl_3$	25C, > ~5% RH	deliquescence			Waller 1992; Hazen & Ausubel 2016
				hydrolysis		to hydrous iron oxide	King 1985
8.11.2	hydromolysite	$FeCl_3 \cdot 6H_2O$	25C, > ~5% RH	deliquescence			Waller 1992
8.11.3	rokühnite	$FeCl_2 \cdot 2H_2O$	moist air	hydration		to higher hydration states	Waller 1992
8.11.4	douglasite	$K_2Fe^{2+}Cl_4 \cdot 2H_2O$		deliquescence			Waller 1992; King 1985
				efflorescence			Howie 1984

Halides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Halite


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Next Steps

- additional data
  - new entries
  - further references
  - other organizational systems

- more permanent location
  - own website
  - part of pre-existing database

- enhance usability & interactivity
  - aid search
  - increase information available per mineral
  - pictures exemplifying deterioration


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Halite


Marcasite

Have any relevant research?

- MSD Submission Form @ http://mineralcare.web.ox.ac.uk/database

or

- email: kathryn.royce@ouce.ox.ac.uk

Further Information:

- Reference for Mineral Care: http://mineralcare.web.ox.ac.uk/

Thank you for listening!

The Mineral Stability Database is an output of a collaborative doctoral research project, supported by collaborators from the following institutions:

- University of Oxford, School of Geography & the Environment – Prof. Heather Viles
- National Museum Cardiff – Dr. Jana Horak, Tom Cotterell
- National Museums Liverpool – Dr. Christian Baars
- BSRIA Ltd. – Tom Gagarin
- OR3D – James Earl

The PhD project is part of the Science and Engineering in Arts, Heritage, and Archaeology Centre for Doctoral Training (SEAHA CDT).

Funding has been provided by:

- The Engineering and Physical Sciences Research Council (EPSRC)
- The Barbara Whatmore Trust
- The Pilgrim Trust
- The National Conservation Service