The DP Method

A Novel Semi-Quantitative Method for Surveying Heritage Collections

Kathryn Royce, D.Phil. Candidate, University of Oxford

First things first

- Slides available to download
  - http://mineralcare.web.ox.ac.uk
  - Conferences => NatSCA 2023

- What we're covering today
  - Intro to the DP State Survey Method
  - How to Survey
  - How to Analyse – Basic
  - How to Analyse – Intermediate

How to Excel version

- How to use Excel* to facilitate the surveying process

- Tips mentioned:
  1. Sorting
  2. Freeze Panes
  3. Colour & Lines
  4. Conditional Formatting
  5. Autosum & Autofill
  6. Pivot Tables

* Or any other spreadsheet programme

Position within the Collection Assessment

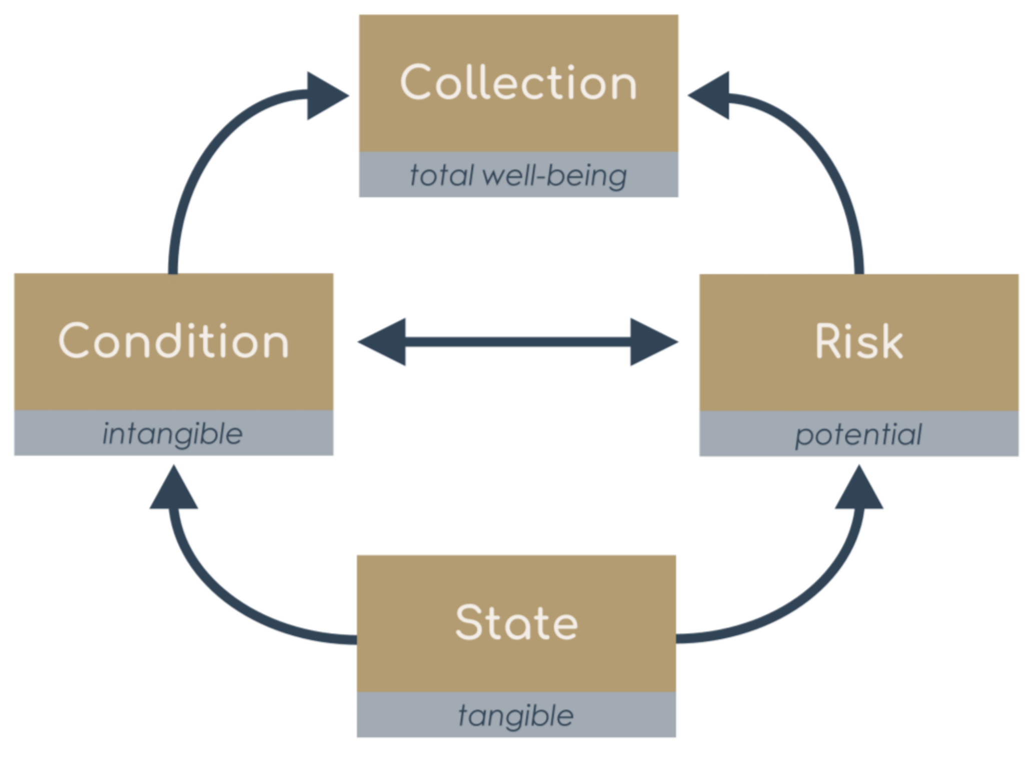
3 parts necessary to assess overall collection well-being

1. **State**: object properties, environment, housing materials
2. **Condition:** values, uses, intactness, appearance, etc.
3. **Risk**: likely exposure & outcomes to agents of change

The DP Method

Focuses on state rather than condition

- Enables more quantitative measurements
- Addresses many problems w/ current condition assessment surveys
  - subjectivity, ambiguity, variability



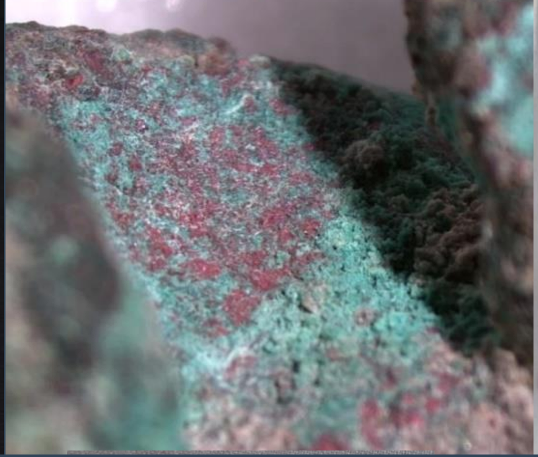
Deterioration Phenomena (DP)

Dimple	Rounded	Corrosion	Tarnish	fflorescence	Powder	Crumbling	Flaking	Breakages	Cracks	Dull/Matte	Darker	Lighter	Opacity	olour Change
0	0	1	1	0	0	0	0	0	1	1	0	0	0	1
0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
0	0	1	0	0	0	0	0	0	1	1	0	0	0	1
0	0	0	1	0	0	1	0	1	1	0	0	0	0	0
0	0	0	1	0	0	0	0	0	1	1	1	0	0	1
0	0	0	1	0	0	1	0	1	1	1	0	0	0	1
0	0	1	1	0	0	0	0	0	0	0	1	0	0	1
0	0	0	1	0	0	0	0	0	1	1	0	0	0	0
0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
0	0	0	1	0	0	0	0	0	0	0	1	0	0	1
0	0	1	1	0	0	0	0	0	0	0	0	0	0	1
0	0	0	1	1	0	0	0	0	1	0	0	0	0	1
0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	1	0	0	1	0	0	1	1	0	0	0	1
0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
0	0	0	1	0	0	0	0	1	1	0	0	0	0	0
0	0	0	1	0	0	1	0	0	1	1	0	0	0	0
0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

- Visually indicative of change to given collection
  - Not all DP applicable to every object
  - Some DP more indicative of deterioration than others
- Limited & pre-defined
- Presence/absence only (1 / 0)
  - No determination of extent/severity
  - Increase speed, reduce variability, avoid assigning quantitative values to subjective perception
- Cause of change attributed during data analysis
  - Minimise distraction, interpretational bias, & attribution error


Dimpled


Rounded


Corrosion

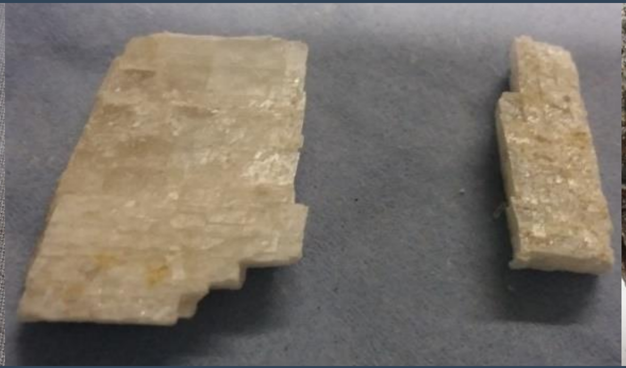

Tarnish


Efflorescence


Powder


Crumbling


Flaking


Breakages


Cracks


Dull


Dark


Pale

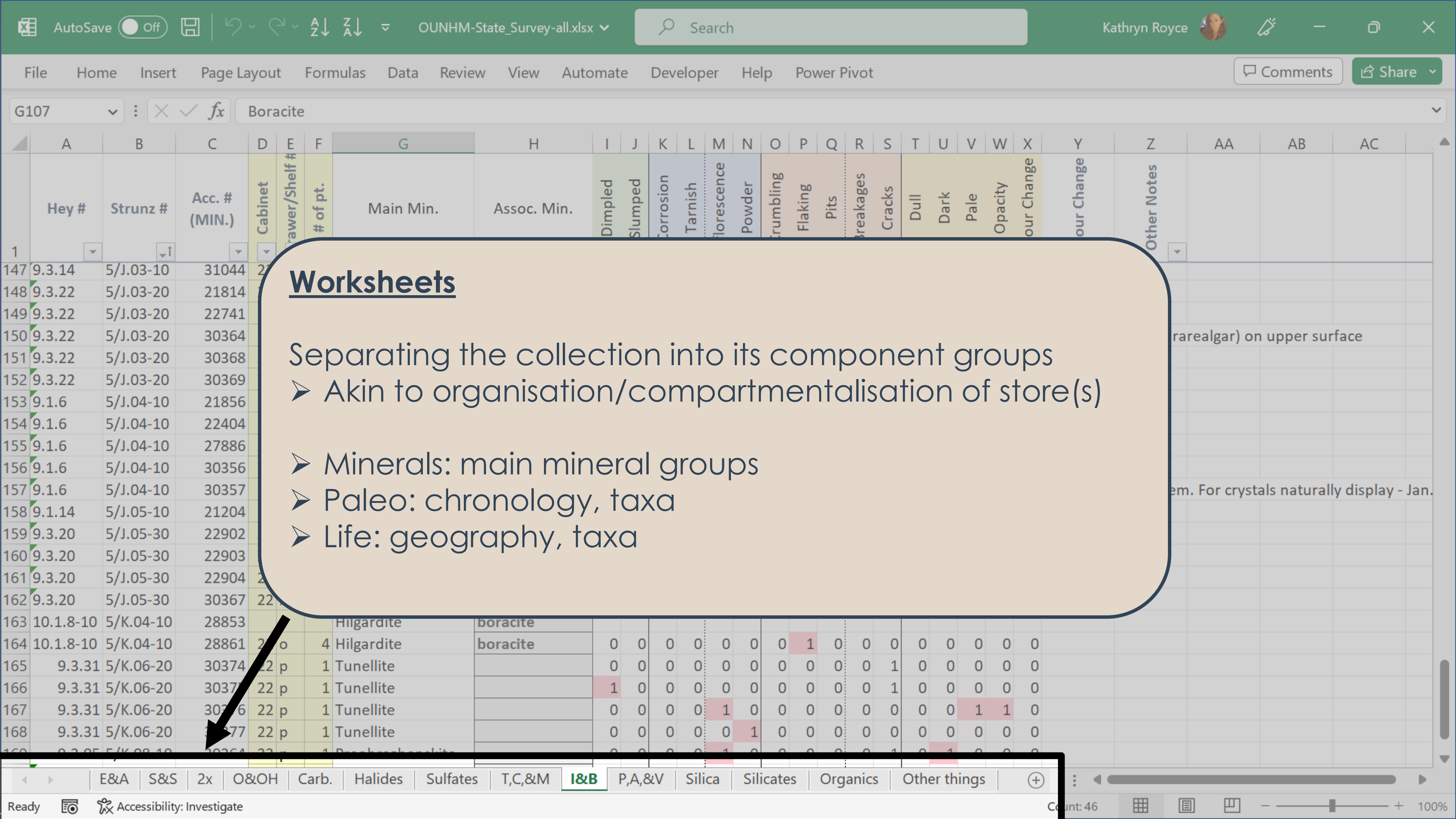

Opacity


Colour Change

Dark Coloured mineral is a darker shade of that colour or black	
Pale Coloured mineral is a lighter shade of that colour or white/colourless	
Opacity Mineral has become 'clouded', translucent, or opaque	

Pre-Survey

1. Identify the collection(s) to survey
2. Select DP that reflect how those collection items deteriorate
   - Must be visual change
   - Doesn't have to be quantifiable
3. Define the DP
   - Verbally
   - Pictorially
4. Collect pre-existing object information from CMS
   - Accession/object number
   - Species name/material type
5. Set up your survey spreadsheet

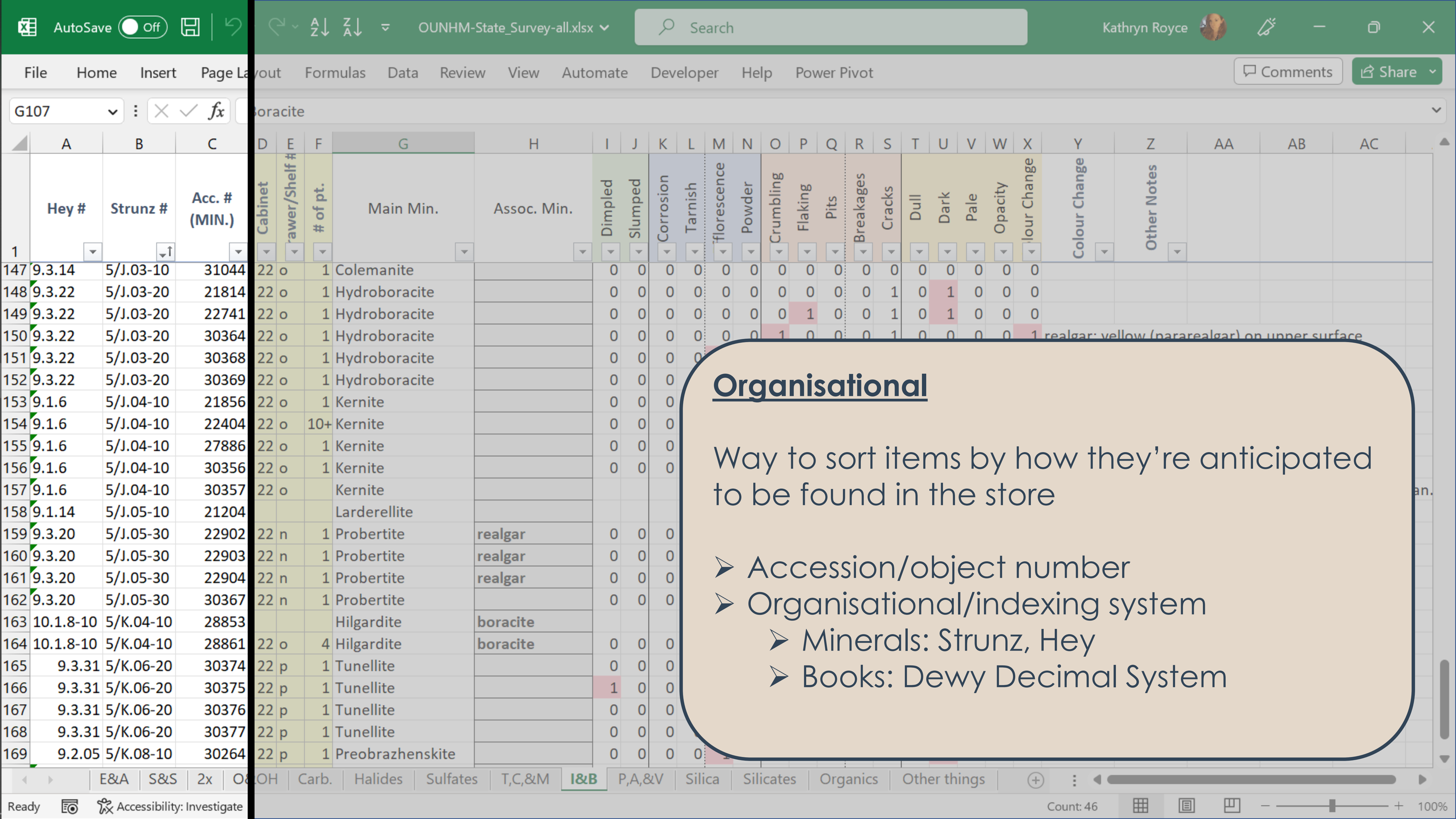


Worksheets

Separating the collection into its component groups

- Akin to organisation/compartmentalisation of store(s)

- Minerals: main mineral groups
- Paleo: chronology, taxa
- Life: geography, taxa



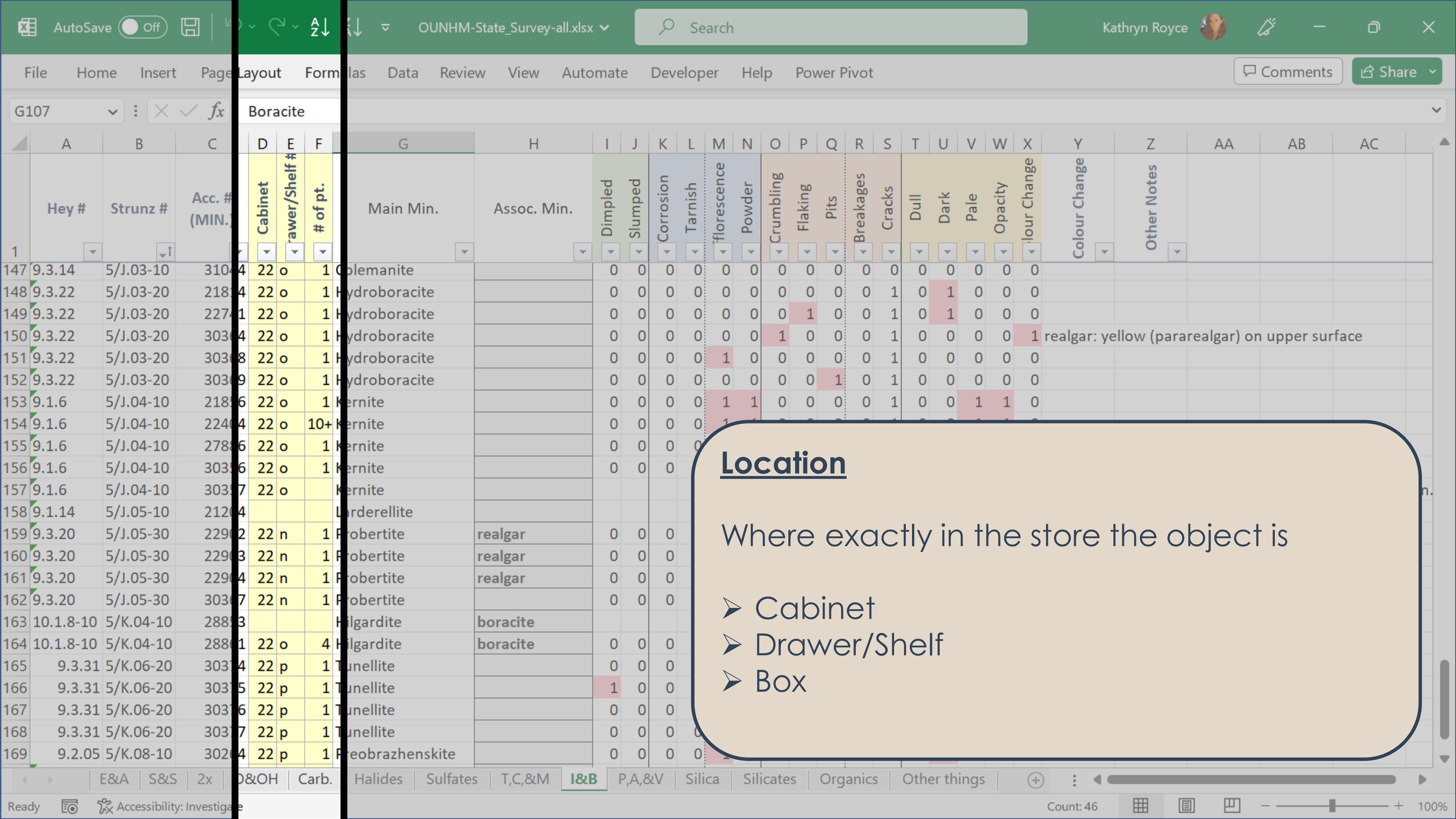
	Hey #	Strunz #	Acc. # (MIN.)	Cabinet	awer/Shelf #	# of pt.	Main Min.	Assoc. Min.	Dimpled	Slumped	Corrosion
147	9.3.14	5/J.03-10	31044	22	o	1	Colemanite		0	0	0
148	9.3.22	5/J.03-20	21814	22	o	1	Hydroboracite		0	0	0
149	9.3.22	5/J.03-20	22741	22	o	1	Hydroboracite		0	0	0
150	9.3.22	5/J.03-20	30364	22	o	1	Hydroboracite		0	0	0
151	9.3.22	5/J.03-20	30368	22	o	1	Hydroboracite		0	0	0
152	9.3.22	5/J.03-20	30369	22	o	1	Hydroboracite		0	0	0
153	9.1.6	5/J.04-10	21856	22	o	1	Kernite		0	0	0
154	9.1.6	5/J.04-10	22404	22	o	10+	Kernite		0	0	0
155	9.1.6	5/J.04-10	27886	22	o	1	Kernite		0	0	0
156	9.1.6	5/J.04-10	30356	22	o	1	Kernite		0	0	0
157	9.1.6	5/J.04-10	30357	22	o		Kernite				
158	9.1.14	5/J.05-10	21204				Larderellite				
159	9.3.20	5/J.05-30	22902	22	n	1	Probertite	realgar	0	0	0
160	9.3.20	5/J.05-30	22903	22	n	1	Probertite	realgar	0	0	0
161	9.3.20	5/J.05-30	22904	22	n	1	Probertite	realgar	0	0	0
162	9.3.20	5/J.05-30	30367	22	n	1	Probertite		0	0	0
163	10.1.8-10	5/K.04-10	28853				Hilgardite	boracite			
164	10.1.8-10	5/K.04-10	28861	22	o	4	Hilgardite	boracite	0	0	0
165	9.3.31	5/K.06-20	30374	22	p	1	Tunellite		0	0	0
166	9.3.31	5/K.06-20	30375	22	p	1	Tunellite		1	0	0
167	9.3.31	5/K.06-20	30376	22	p	1	Tunellite		0	0	0
168	9.3.31	5/K.06-20	30377	22	p	1	Tunellite		0	0	0
169	9.2.05	5/K.08-10	30264	22	p	1	Preobrazhenskite		0	0	0

	Tarnish	florescence	Powder	Crumbling	Flaking	Pits	Breakages	Cracks	Dull	Dark	Pale	Opacity	lour Change	Colour Change	Other Notes
147	0	0	0	0	0	0	0	0	0	0	0	0	0		
148	0	0	0	0	0	0	0	1	0	1	0	0	0		
149	0	0	0	0	1	0	0	1	0	1	0	0	0		
150	0	0	0	1	0	0	0	1	0	0	0	0	1	realgar: yellow (pararealgar) on upper surface	

Organisational

Way to sort items by how they're anticipated to be found in the store

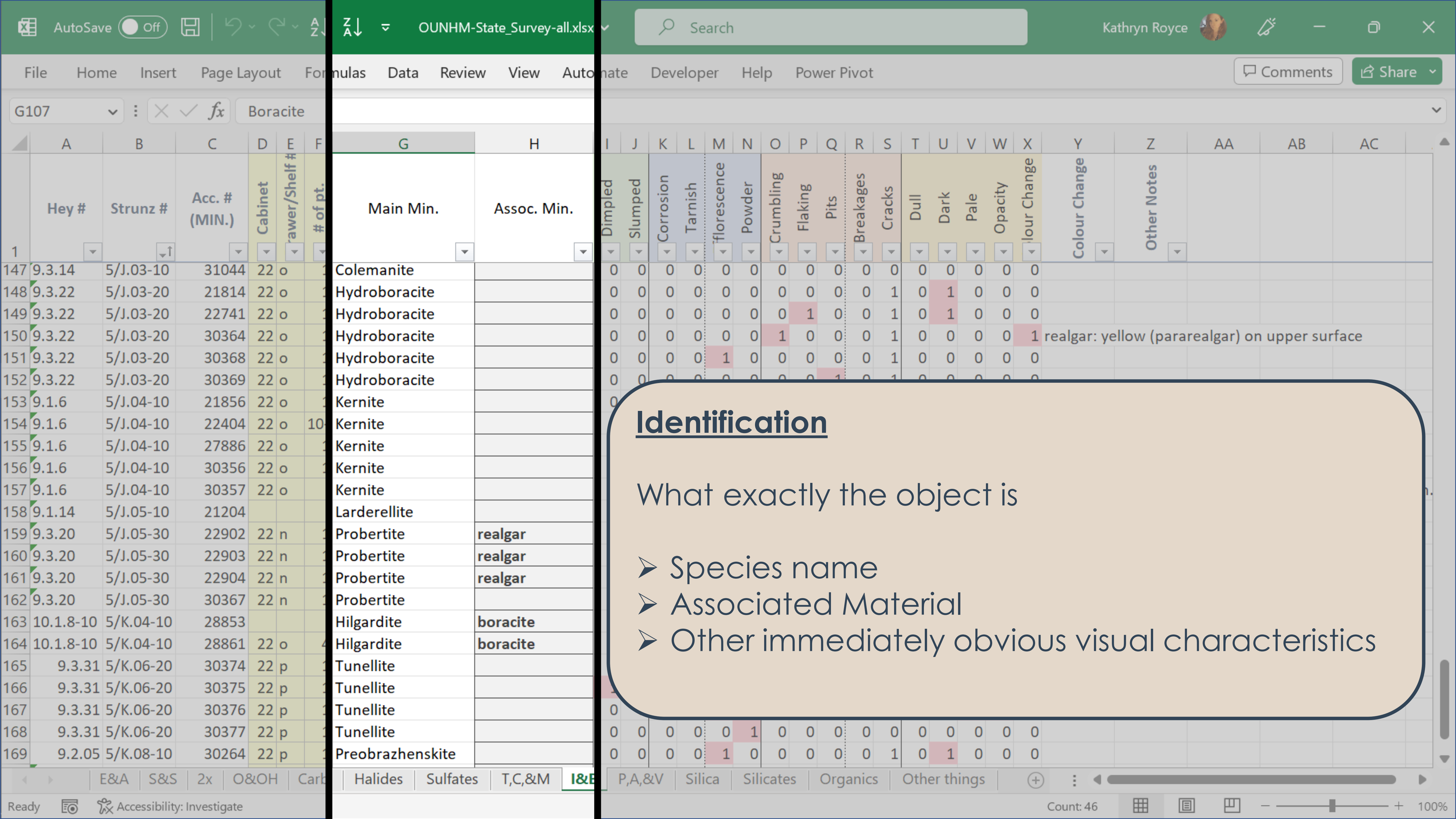
- Accession/object number
- Organisational/indexing system
  - Minerals: Strunz, Hey
  - Books: Dewey Decimal System



Location

Where exactly in the store the object is

- Cabinet
- Drawer/Shelf
- Box

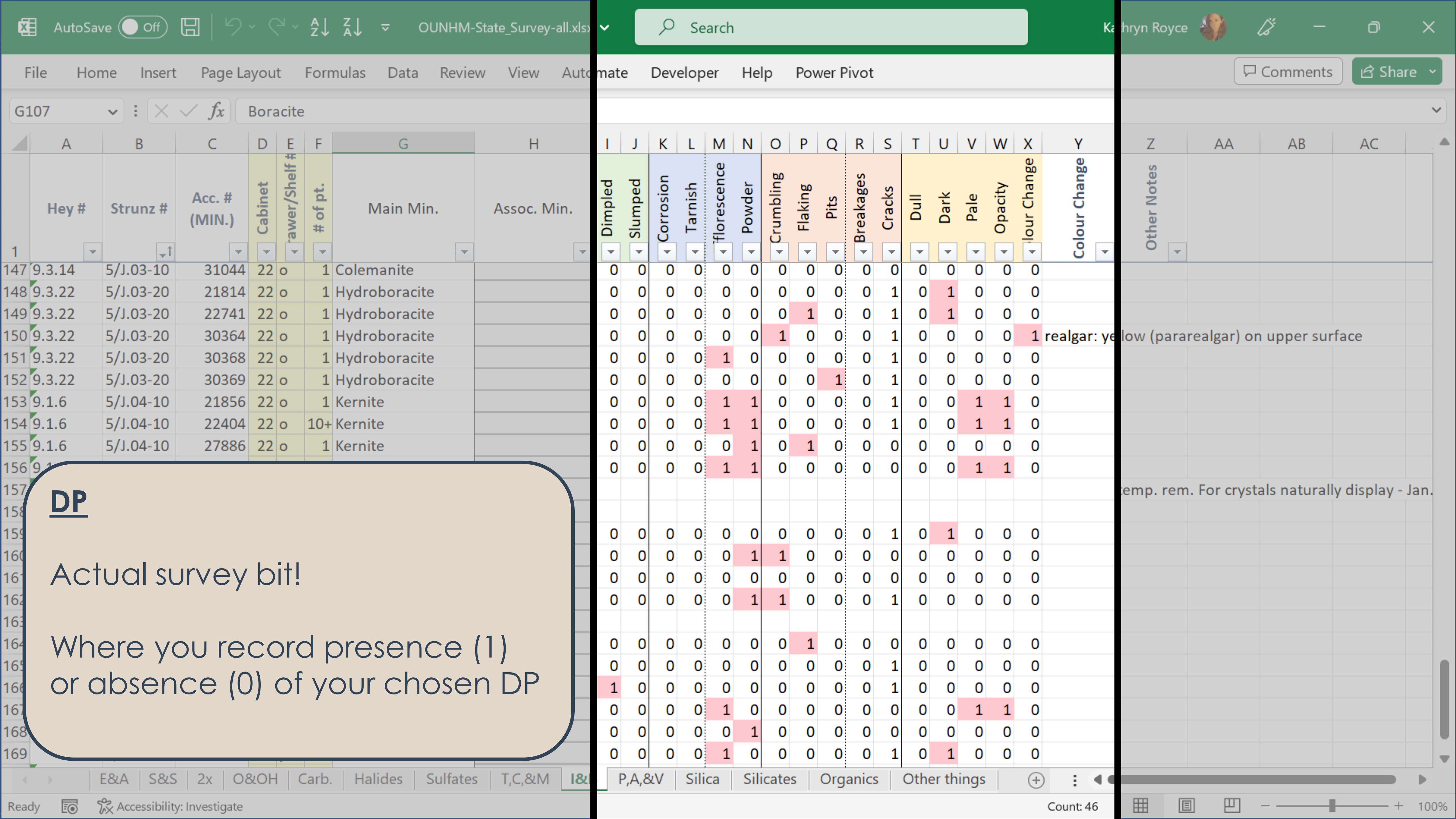


	Hey #	Strunz #	Acc. # (MIN.)	Cabinet	Drawer/Shelf #	# of pt.	Main Min.	Assoc. Min.
147	9.3.14	5/J.03-10	31044	22	o	1	Colemanite	
148	9.3.22	5/J.03-20	21814	22	o	1	Hydroboracite	
149	9.3.22	5/J.03-20	22741	22	o	1	Hydroboracite	
150	9.3.22	5/J.03-20	30364	22	o	1	Hydroboracite	
151	9.3.22	5/J.03-20	30368	22	o	1	Hydroboracite	
152	9.3.22	5/J.03-20	30369	22	o	1	Hydroboracite	
153	9.1.6	5/J.04-10	21856	22	o	1	Kernite	
154	9.1.6	5/J.04-10	22404	22	o	10	Kernite	
155	9.1.6	5/J.04-10	27886	22	o	1	Kernite	
156	9.1.6	5/J.04-10	30356	22	o	1	Kernite	
157	9.1.6	5/J.04-10	30357	22	o	1	Kernite	
158	9.1.14	5/J.05-10	21204				Larderellite	
159	9.3.20	5/J.05-30	22902	22	n	1	Probertite	realgar
160	9.3.20	5/J.05-30	22903	22	n	1	Probertite	realgar
161	9.3.20	5/J.05-30	22904	22	n	1	Probertite	realgar
162	9.3.20	5/J.05-30	30367	22	n	1	Probertite	
163	10.1.8-10	5/K.04-10	28853				Hilgardite	boracite
164	10.1.8-10	5/K.04-10	28861	22	o	4	Hilgardite	boracite
165	9.3.31	5/K.06-20	30374	22	p	1	Tunellite	
166	9.3.31	5/K.06-20	30375	22	p	1	Tunellite	
167	9.3.31	5/K.06-20	30376	22	p	1	Tunellite	
168	9.3.31	5/K.06-20	30377	22	p	1	Tunellite	
169	9.2.05	5/K.08-10	30264	22	p	1	Preobrazhenskite	

Identification

What exactly the object is

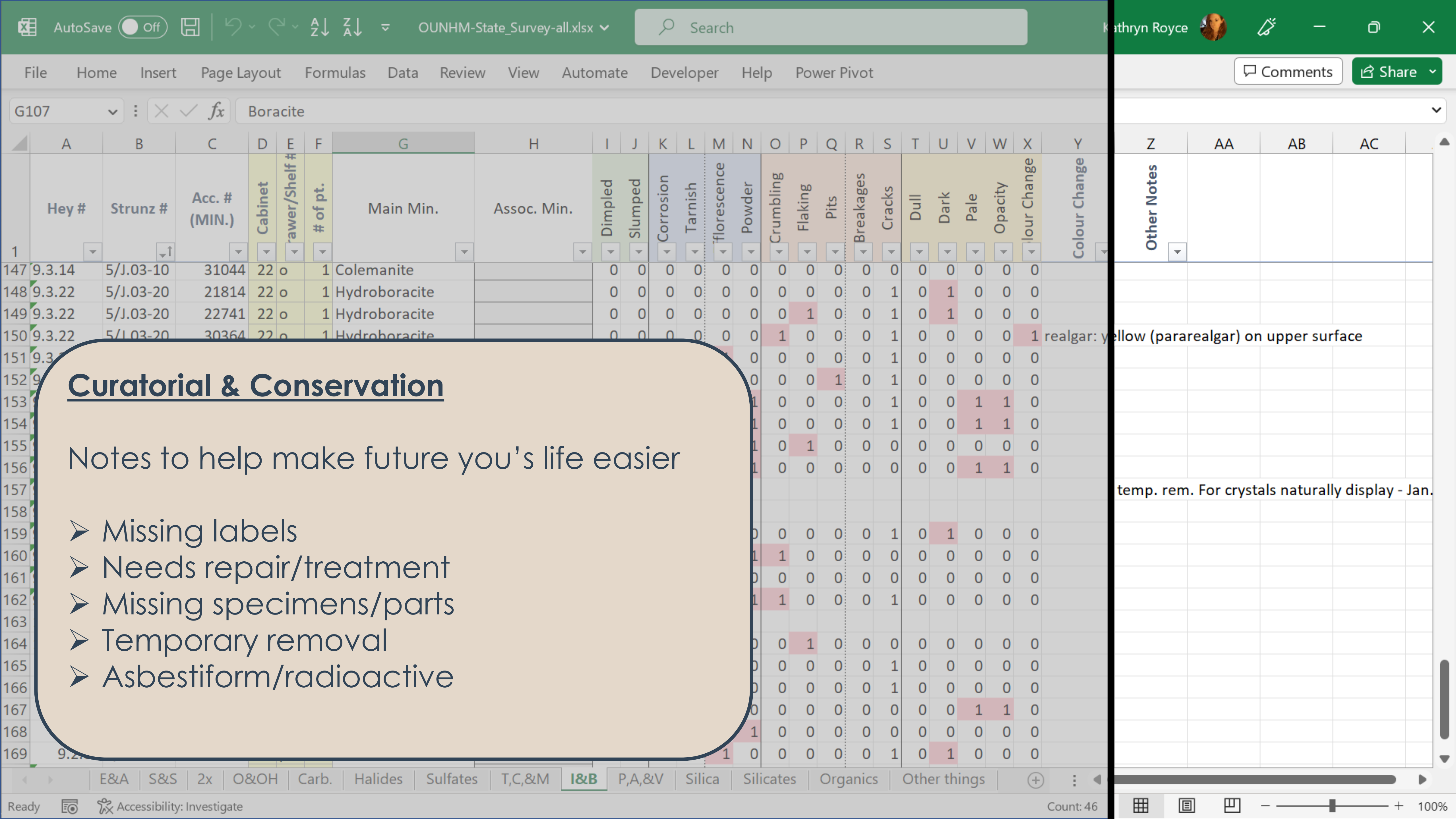
- Species name
- Associated Material
- Other immediately obvious visual characteristics



DP

Actual survey bit!

Where you record presence (1) or absence (0) of your chosen DP



Curatorial & Conservation

Notes to help make future you's life easier

- Missing labels
- Needs repair/treatment
- Missing specimens/parts
- Temporary removal
- Asbestiform/radioactive

Surveying

fairly straightforward

1. examine object for DP
2. type in corresponding 0s & 1s
3. enter any additional information (e.g., location, habit)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1	Cabinet	Drawer/Shelf #	# of pt.	Main Min.	Assoc. Min.	Form/Habit	Location	Dewy	Slumped	Corrosion	Tarnish	Efflorescence	Powder	Crumbling	Delamination	Flaking	Pits	Breakages	Cracks	Dull/Matte	Darker	Lighter	Opacity	Colour Change
2	6	f	1	pyrite		pyritohedral, aggregate	unknown	0	0	0	1	0	0	0	0	0	0	0	1	1	1	0	0	0

Surveying

fairly straightforward

1. examine object for DP
2. type in corresponding 0s & 1s
3. enter any additional information (e.g., location, habit)

- SAVE FREQUENTLY
- Treat first few days as pilot
  - confirm DP applicable & sufficiently defined
  - identify skipping methods
  - adjust setup or approach

Skipping Specimens

OK to skip

1. minerals in microenvironments (bagged, boxed)
2. bagged asbestiform
3. well-represented species (e.g., quartz, calcite, fluorite)

If a species > 50 specimens,

- min. = 50; max. = 200
- usually ~25% of total specimens
  - use parametric statistical methods
  - statistically representative sample size

Identifying Deterioration

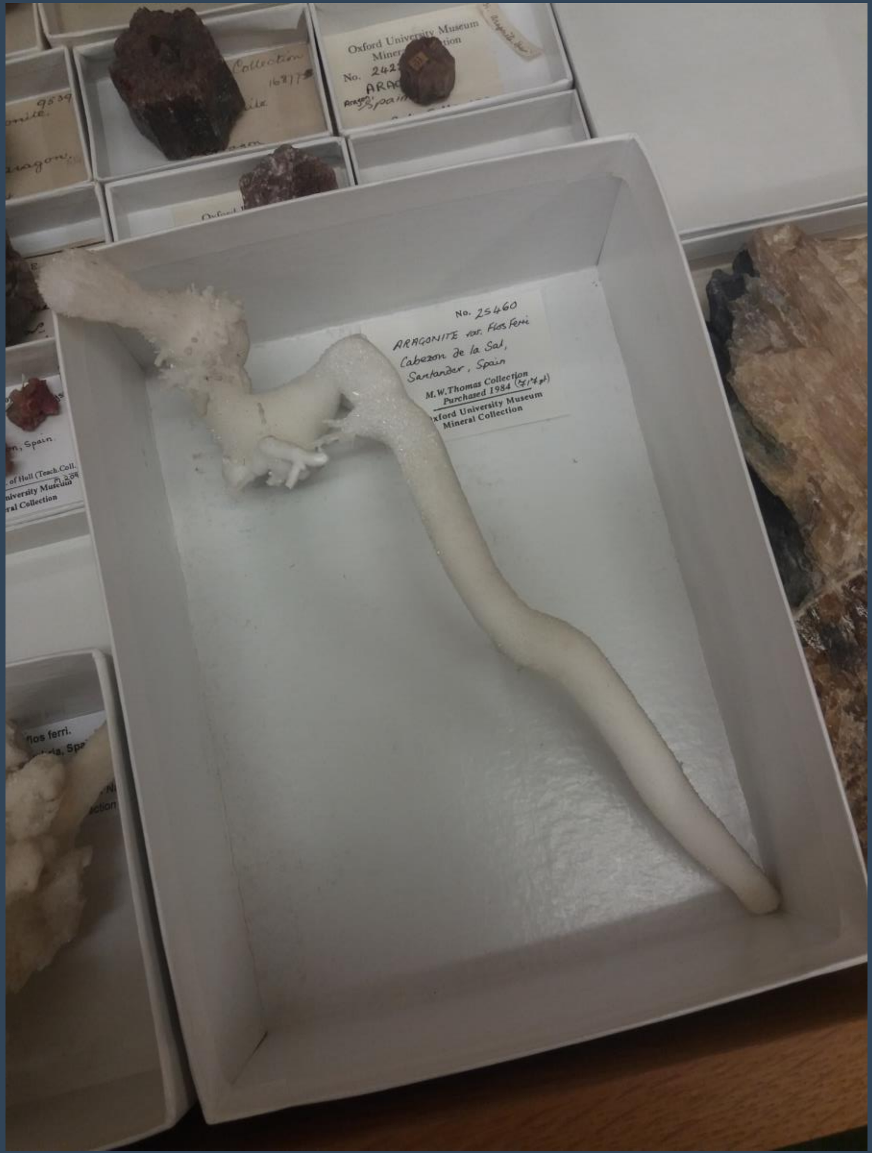
- Presence of multiple DP suggests deterioration has occurred
- Out of scope of survey to determine if active or not
  - Cannot be determined by visual observations alone

- Certain combinations suggest potential reaction types:
  - surficial oxidation
  - oxidation at depth
  - pollutant-induced oxidation
  - efflorescence
  - surface wetting
  - physical forces

How to Analyse - Basic

<u>Simple Exploratory</u>

- Frequencies & Averages
- Addresses the ‘what’
- Performed in Excel
  - only w/ survey data
  - facilitated by Pivot tables
- Visual pattern recognition & mapping to reaction type
  - 1st order = affects > 50%
  - 2nd order = affects < 50%



Key Metrics

I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
Dimpled	Slumped	Corrosion	Tarnish	florescence	Powder	Crumbling	Flaking	Pits	Breakages	Cracks	Dull	Dark	Pale	Opacity	lour Change	Total	Colour Change
0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	4	
0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	2	
0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	2	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	3	
0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	
0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	
1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	
0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	3	
0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	
0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	3	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
																2	ADP

Total DP

- ➢ Sum of all present DP
- ➢ Total of all the 1's in each row
- ➢ Calculated w/ AutoSum

Average DP (ADP)

- ➢ Average of all total DP
- ➢ Represents average number of DP seen per object
- ➢ Calculated w/ AutoAverage

Percent DP (%DP) & their Patterns

- % average of DP observed / species, etc.
- Used to determine 1st & 2nd order cause of deterioration

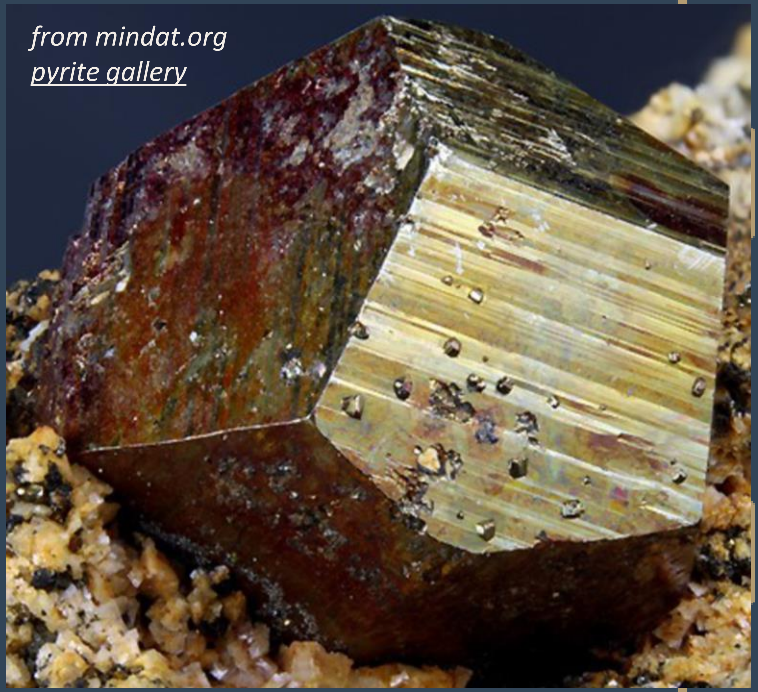
	Average														Type of deterioration	
MINERAL	**% Dim**	**% Tarr**	**% Efflc**	**% Pow**	**% Crui**	**% Flak**	**% Pits**	**% Brea**	**% Crac**	**% Dull**	**% Darl**	**% Pale**	**% Opa**	**% Colc**	**1st Order**	**2nd Order**
Vonsenite	0%	0%	0%	0%	0%	0%	0%	0%	100%	25%	0%	0%	0%	0%	Physical forces	Surfical Oxidation
Fluoborite	0%	0%	67%	0%	0%	0%	0%	0%	67%	0%	0%	0%	0%	0%	Efflorescence	—
Berborite	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	—	—
Wightmanite	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	—	—
Canavesite	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	100%	Surfical Oxidation	—
Sulfoborite	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	—	—
Szaibelyite	0%	0%	50%	0%	0%	0%	0%	0%	50%	0%	0%	50%	0%	0%	Efflorescence	—
Sussexite	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	—	—
Pinnoite	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	Physical forces	—
Kurnakovite	0%	0%	100%	100%	0%	0%	0%	0%	50%	0%	0%	100%	100%	0%	Efflorescence	—
Inderite	0%	0%	100%	100%	0%	0%	0%	0%	100%	0%	0%	100%	100%	0%	Efflorescence	—
Inderborite	0%	0%	0%	100%	0%	0%	0%	0%	100%	0%	0%	0%	0%	33%	Physical forces	—
Meyerhofferite	0%	0%	0%	100%	75%	0%	0%	50%	25%	0%	0%	0%	0%	0%	Physical forces	—
Inyoite	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	100%	0%	0%	0%	Physical forces	—
Tincalconite	0%	0%	0%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%	Physical forces	—
Borax	0%	0%	0%	100%	33%	17%	0%	0%	17%	0%	0%	0%	0%	67%		
Boracite	29%	0%	5%	0%	0%	0%	0%	3%	8%	0%	34%	0%	0%	0%	—	surface wetting
Ulexite	0%	0%	7%	64%	36%	7%	0%	0%	21%	0%	64%	7%	0%	14%		
Colemanite	29%	0%	18%	12%	6%	6%	0%	12%	35%	0%	12%	0%	0%	0%	—	surface wetting
Hydroboracite	0%	0%	20%	0%	20%	20%	20%	0%	100%	0%	40%	0%	0%	20%	Physical forces	—
Kernite	0%	0%	75%	100%	0%	25%	0%	0%	50%	0%	0%	75%	75%	0%	Dehydration	—
Probertite	0%	0%	0%	50%	50%	0%	0%	0%	50%	0%	25%	0%	0%	0%	Physical forces	—
Hilgardite	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	Physical forces	—
Tunellite	25%	0%	25%	25%	0%	0%	0%	0%	50%	0%	0%	25%	25%	0%	Physical forces	surface wetting
Preobrazhenskite	0%	0%	100%	0%	0%	0%	0%	0%	100%	0%	100%	0%	0%	0%	Efflorescence	
Braitschite-(Ce)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	—	—
Hambergite	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	—	—
Total	13%	1%	16%	29%	11%	4%	1%	4%	34%	1%	22%	10%	7%	7%	—	Physical forces

Conditional Formatting Key	
75–100%	Red
50–74%	Orange
25–49%	Yellow
0–24%	N/A

%DP Patterns Example: Pyrite

DP	%DP	# of spec.
Corrosion	11%	143
Tarnish	86%	1,095
Efflorescence	23%	295
Powder	7%	85
Crumbling	21%	271
Flaking	5%	60
Breakages	9%	117
Cracks	56%	715
Dull	78%	990
Dark	57%	729
Colour Change	33%	422
Total # of specimens	1,274	

- 1st Order: Surficial Oxidation
  ↳ Dull & Tarnish > 75%
- 2nd Order: Oxidation at Depth
  ↳ Signs of Pyrite Decay < 25%
  - Efflorescence
  - Powder
  - Crumbling
  - Breakages



How to Analyse - Intermediate

<u>Extended Exploratory</u>

- Contextualise survey data w/ associated information
- Can supplement w/ data from analytical methods
- Begins to address the ‘why’
- Performed in Excel w/ pivot tables
  - ADPs & %DP patterns
- Examine data subsets
  - Location in store
  - Locality/Geography
  - Habit/Form
  - Different storage conditions

Location in Store

	Strunz #	Acc. # (MIN.)	Cabinet	Drawer/Shelf #	# of pt.	Main Min.	Total
2	4/L.02-10	19543	22	m	1	Salesite	0
3	4/L.02-20	19530	22	m	1	Bellingerite	1
4	5/	22305	22	p	1	Rhodizite	0
5	5/G.03-10	21203	22	m	2	Warwickite	2
6	5/G.03-20	21107	22	m	1	Pinakiolite	0
7	5/G.04-10	16995	22	m	1	Ludwigite	1
8	5/G.04-10	26882	22	m	1	Ludwigite	1
9	5/G.04-10	27309	22	m	1	Ludwigite	1
10	5/G.04-10	28832	22	m	1	Ludwigite	2
11	5/G.04-10	26526	22	m	1	Gaudefroyite	0
12	5/G.04-20	21850	22	m	1	Vonsenite	1
13	5/G.04-20	26348	22	m	1	Vonsenite	1
14	5/G.04-20	26349	22	m	1	Vonsenite	1
15	5/G.04-20	27590	22	m	1	Vonsenite	2
16	5/G.05-10	21827	22	m	1	Fluoborite	1
17	5/G.05-10	26869	22	m	1	Fluoborite	1
18	5/G.05-10	27510	22	m	1	Fluoborite	2
19	5/G.06-10	26422	22	m	1	Berborite	0
20	5/G.06-20	21848	22	m	1	Wightmanite	0
21	5/G.06-40	27575	22	p	1	Canavesite	3
22	5/G.11-10	1297	22	m	9	Sulfoborite	0
23	5/H.02-10	21843	22	m	1	Szaibelyite	2
24	5/H.02-10	26412	22	m	1	Szaibelyite	1

I&B | Total | DP | Location

Cabinets

Drawers

Average of Total		
Row Labels	**22**	**Grand Total**
m	**2**	**2**
n	**2**	**2**
o	**2**	**2**
p	**1**	**1**
Boracite	1	1
Canavesite	3	3
Preobrazhenskite	3	3
Rhodizite	0	0
Tunellite	2	2
Grand Total	**2**	**2**

Use ADP to find hotspots
➢ Source of leak/pests

PivotTable Fields

Choose fields to add to report:

Search

- [ ] Strunz #
- [ ] Acc. # (MIN.)
- [x] Cabinet
- [x] Drawer/Shelf #
- [ ] # of pt.
- [x] Main Min.
- [x] Total

More Tables...

Drag fields between areas below:

Filters

Columns: Cabinet

Rows: Drawer/Shelf #, Main Min.

Values: Average of Total

Defer Layo... Update

Use as Category or Filter in Pivot Tables

AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC
Locality	# of spec.	Corrosion	Tarnish	Efflorescence	Powder	Crumbling	Flaking	Breakages	Cracks	Dull	Dark	Pale	ColourChange
Algeria	4	25%	100%	0%	0%	0%	0%	0%	0%	50%	50%	0%	50%
Aotearoa (New Zealan	2	0%	100%	50%	0%	0%	0%	0%	50%	100%	50%	0%	0%
Australia	2	0%	100%	50%	0%	50%	0%	0%	50%	100%	50%	0%	0%
Austria	5	20%	100%	0%	0%	40%	0%	0%	80%	80%	20%	20%	40%
Bolivia	3	33%	100%	33%	0%	67%	0%	0%	100%	100%	100%	0%	67%
Brazil	8	50%	88%	0%	0%	0%	0%	13%	50%	75%	50%	0%	63%
Canada	9	22%	89%	0%	11%	22%	0%	11%	44%	89%	44%	0%	44%
Chile	3	0%	67%	0%	0%	0%	0%	0%	33%	33%	33%	0%	0%
Colombia	4	0%	100%	25%	0%	25%	0%	0%	75%	100%	25%	25%	0%
Cyprus	6	0%	100%	33%	0%	17%	0%	0%	50%	100%	33%	17%	0%
Democratic Republic c	1	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
Denmark	1	0%	0%	100%	0%	0%	100%	0%	100%	100%	0%	100%	0%
England	265	22%	89%	22%	3%	23%	4%	13%	56%	88%	67%	2%	35%
Finland	1	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
France	12	0%	75%	17%	0%	0%	0%	0%	17%	42%	33%	0%	25%
Germany	7	29%	100%	43%	0%	29%	0%	0%	57%	100%	43%	14%	14%
Greenland	1	0%	100%	0%	0%	0%	0%	0%	100%	100%	0%	0%	0%
Hungary	2	0%	50%	0%	0%	0%	0%	0%	0%	50%	50%	0%	0%
Iceland	1	0%	100%	0%	0%	0%	0%	0%	0%	100%	100%	0%	0%
Iran	1	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%
Ireland	6	0%	100%	17%	0%	17%	0%	17%	100%	100%	83%	0%	33%
Italy	112	6%	95%	29%	16%	38%	13%	21%	70%	67%	49%	1%	44%
Japan	3	33%	67%	0%	0%	33%	33%	33%	33%	67%	33%	0%	67%
Kosovo	1	0%	100%	0%	0%	0%	0%	0%	0%	100%	100%	0%	0%
Mexico	7	14%	57%	0%	0%	29%	0%	0%	57%	71%	43%	0%	14%
North Africa	1	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Pyrite Locality (Country)	England	Italy	Peru	Spain	USA	Wales
# of spec.	265	112	25	28	52	219
Corrosion	22%	6%	0%	7%	8%	1%
Tarnish	89%	95%	60%	54%	83%	86%
Effloresce	22%	29%	8%	18%	6%	26%
Powder	3%	16%	0%	0%	4%	3%
Crumbling	23%	38%	4%	29%	10%	23%
Flaking	4%	13%	0%	0%	0%	3%
Breakages	13%	21%	0%	4%	6%	4%
Cracks	56%	70%	40%	57%	31%	66%
Dull	88%	67%	32%	54%	65%	73%
Dark	67%	49%	12%	21%	35%	57%
Pale	2%	1%	4%	18%	2%	7%
ColourCha	35%	44%	16%	18%	27%	26%

Identify:

- main contributors
- areas for further exploration & analysis

	Locality	# of spec.	1st Order	2nd Order
England	*Cornwall*	96	Surficial Oxidation	Physical Forces
	Cumbria	33	Surficial Oxidation	Physical Forces
	Devon	29	Surficial Oxidation	Oxidation At Depth
	Kent	13	Surficial Oxidation	Oxidation At Depth
Italy	*Piedmont*	49	Surficial Oxidation	Oxidation At Depth
	Tuscany	57	Surficial Oxidation	Physical Forces
Peru	*La Libertad Department*	8	Surficial Oxidation	
Spain	*Andalusia*	7	Physical Forces	
	La Rioja	11		Physical Forces
USA	*Colorado*	18	Surficial Oxidation	Physical Forces
	New York	7	Surficial Oxidation	
	Pennsylvania	12	Surficial Oxidation	Physical Forces
Wales	*Carmarthenshire*	26	Surficial Oxidation	Oxidation At Depth
	Ceredigion	15	Surficial Oxidation	Physical Forces
	Denbighshire	13	Surficial Oxidation	Oxidation At Depth
	Gwynedd	102	Surficial Oxidation	Physical Forces
	Powys	12	Physical Forces	Surficial Oxidation
	Vale of Glamorgan	18	Surficial Oxidation	Physical Forces

How far to push your subsets?

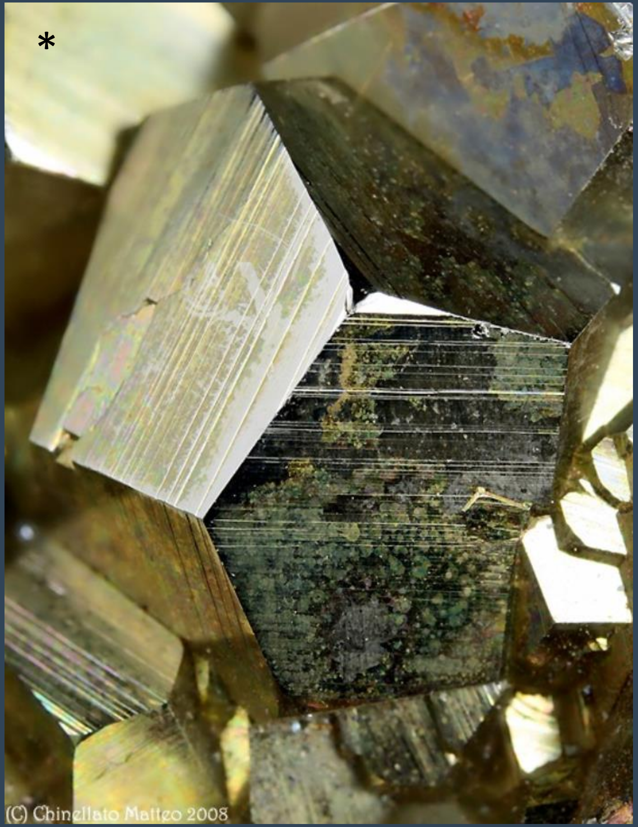
As far* as they can go

- Can find interesting info & trends
  - Reveal previously unknown relationships
  - Provide further areas for research

* To maintain statistical rigor *
(& to be able to use parametric methods)
datasets should consist of
at least 30 objects

Rio La Marina

Elba, Tuscany, Italy



	Rio	Elba	All
# of spec.	16	55	1,274
Corr.	0%	7%	11%
Tarnish	100%	95%	86%
Efflor.	31%	24%	23%
Powder	6%	5%	7%
Crumb.	38%	33%	21%
Flaking	0%	16%	5%
Break.	6%	16%	9%
Cracks	63%	69%	56%
Dull	38%	53%	78%
Dark	6%	24%	57%
Colour Change	50%	33%	33%
ADP	**3**	**4**	**4**

**Photos from mindat.org - pyrite gallery*

Preview: Advanced Statistical Analysis

Formal Analysis

- Performed in SPSS
- Bivariate correlation:
  Pearson's correlation coefficient (*r*)
- Factor analysis:
  Principal Component Analysis
  - Observe multi-dimension association
  - Dimensionality reduction: see which variables to remove/combine
- Reliability analysis:
  Cronbach's Alpha (ρ_T)

Results are comparable to 'Basic' Analysis

Differences:
- More in-depth findings
- Produces numerical values (e.g., test statistics)

Get in touch if you would like a walk-through of the SPSS analysis

kathryn.royce@ouce.ox.ac.uk

the DP Method: a summary

- **SEMI-QUANTITATIVE & STATISTICALLY RIGOROUS**
  - Solid foundation for collection assessments
  - Can track changes over time
  - Used to infer reaction pathways
  - Supplement w/ contextual info
- **CUSTOMISABLE** to collection/material type
- **FAST** data collection: ~ 1 minute/specimen*
- **COMPATIBLE** w/ any spreadsheet programme

Walk-through videos & documents coming soon!

http://mineralcare.web.ox.ac.uk

*speed may differ for XL specimens

Thank you for listening!

This work 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

SEAHA
EPSRC CENTRE FOR DOCTORAL TRAINING SCIENCE AND ENGINEERING IN ARTS HERITAGE AND ARCHAEOLOGY

SoGE | School of Geography and the Environment

UNIVERSITY OF OXFORD

national museum cardiff
amgueddfa genedlaethol caerdydd

OR3D Digitise Dimension Design

BSRIA

National Museums Liverpool

Questions?

kathryn.royce@ouce.ox.ac.uk

http://mineralcare.web.ox.ac.uk

AutoSave Off OUNHM-State_Survey-all.xlsx Search Kathryn Royce

File Home Insert Page Layout Formulas Data Review View Automate Developer Help Power Pivot Comments Share

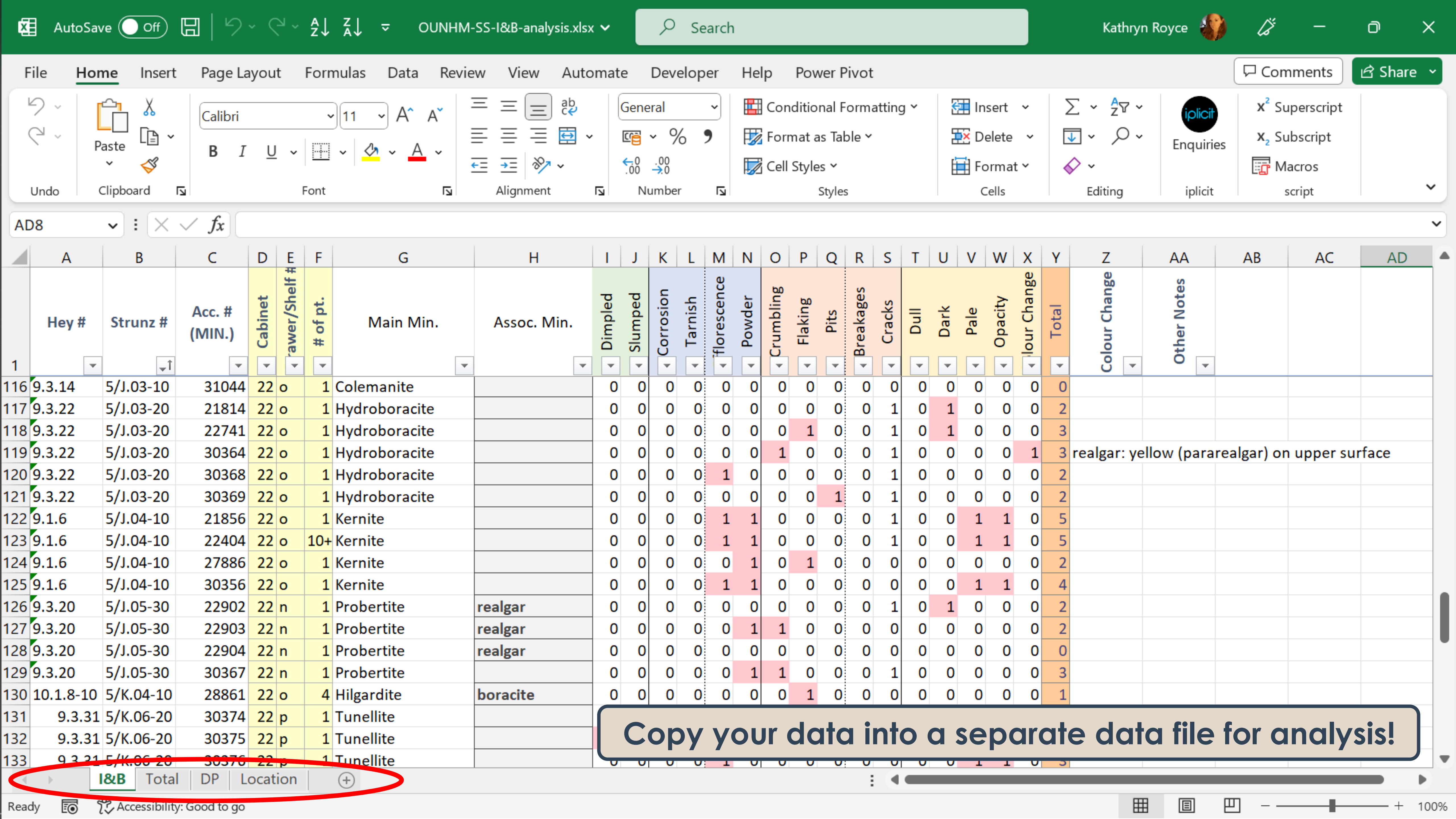
G107 Boracite

	Hey #	Strunz #	Acc. # (MIN.)	Cabinet	awer/Shelf #	# of pt.	Main Min.	Assoc. Min.	Dimpled	Slumped	Corrosion	Tarnish	florescence	Powder	Crumbling	Flaking	Pits	Breakages	Cracks	Dull	Dark	Pale	Opacity	lour Change	Colour Change	Other Notes
147	9.3.14	5/J.03-10	31044	22	o	1	Colemanite		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
148	9.3.22	5/J.03-20	21814	22	o	1	Hydroboracite		0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0		
149	9.3.22	5/J.03-20	22741	22	o	1	Hydroboracite		0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0		
150	9.3.22	5/J.03-20	30364	22	o	1	Hydroboracite		0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	realgar: yellow (pararealgar) on upper surface	
151	9.3.22	5/J.03-20	30368	22	o	1	Hydroboracite		0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0		
152	9.3.22	5/J.03-20	30369	22	o	1	Hydroboracite		0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0		
153	9.1.6	5/J.04-10	21856	22	o	1	Kernite		0	0	0	0	1	1	0	0	0	0	1	0	0	1	1	0		
154	9.1.6	5/J.04-10	22404	22	o	10+	Kernite		0	0	0	0	1	1	0	0	0	0	1	0	0	1	1	0		
155	9.1.6	5/J.04-10	27886	22	o	1	Kernite		0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0		
156	9.1.6	5/J.04-10	30356	22	o	1	Kernite		0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0		
157	9.1.6	5/J.04-10	30357	22	o		Kernite																			temp. rem. For crystals naturally display - Jan.
158	9.1.14	5/J.05-10	21204				Larderellite																			
159	9.3.20	5/J.05-30	22902	22	n	1	Probertite	realgar	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0		
160	9.3.20	5/J.05-30	22903	22	n	1	Probertite	realgar	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0		
161	9.3.20	5/J.05-30	22904	22	n	1	Probertite	realgar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
162	9.3.20	5/J.05-30	30367	22	n	1	Probertite		0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0		
163	10.1.8-10	5/K.04-10	28853				Hilgardite	boracite																		
164	10.1.8-10	5/K.04-10	28861	22	o	4	Hilgardite	boracite	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0		
165	9.3.31	5/K.06-20	30374	22	p	1	Tunellite		0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0		
166	9.3.31	5/K.06-20	30375	22	p	1	Tunellite		1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0		
167	9.3.31	5/K.06-20	30376	22	p	1	Tunellite		0	0	0	0	1													
168	9.3.31	5/K.06-20	30377	22	p	1	Tunellite		0	0	0	0	0													
169	9.2.05	5/K.08-10	30264	22	p	1	Preobrazhenskite		0	0	0	0	1													

Example of a complete survey spreadsheet

E&A S&S 2x O&OH Carb. Halides Sulfates T,C,&M I&B P,A,&V Silica Silicates Organics Other things

Ready Accessibility: Investigate Count: 46 100%



1	Hey #	Strunz #	Acc. # (MIN.)	Cabinet	awer/Shelf #	# of pt.	Main Min.	Assoc. Min.	Dimpled	Slumped	Corrosion	Tarnish	florescence	Powder	Crumbling	Flaking	Pits	Breakages	Cracks	Dull	Dark	Pale	Opacity	lour Change	Total	Colour Change	Other Notes
116	9.3.14	5/J.03-10	31044	22	o	1	Colemanite		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
117	9.3.22	5/J.03-20	21814	22	o	1	Hydroboracite		0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	2		
118	9.3.22	5/J.03-20	22741	22	o	1	Hydroboracite		0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	3		
119	9.3.22	5/J.03-20	30364	22	o	1	Hydroboracite		0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	3	realgar: yellow (pararealgar) on upper surface	
120	9.3.22	5/J.03-20	30368	22	o	1	Hydroboracite		0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	2		
121	9.3.22	5/J.03-20	30369	22	o	1	Hydroboracite		0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	2		
122	9.1.6	5/J.04-10	21856	22	o	1	Kernite		0	0	0	0	1	1	0	0	0	0	1	0	0	1	1	0	5		
123	9.1.6	5/J.04-10	22404	22	o	10+	Kernite		0	0	0	0	1	1	0	0	0	0	1	0	0	1	1	0	5		
124	9.1.6	5/J.04-10	27886	22	o	1	Kernite		0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2		
125	9.1.6	5/J.04-10	30356	22	o	1	Kernite		0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	4		
126	9.3.20	5/J.05-30	22902	22	n	1	Probertite	realgar	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	2		
127	9.3.20	5/J.05-30	22903	22	n	1	Probertite	realgar	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	2		
128	9.3.20	5/J.05-30	22904	22	n	1	Probertite	realgar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
129	9.3.20	5/J.05-30	30367	22	n	1	Probertite		0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	3		
130	10.1.8-10	5/K.04-10	28861	22	o	4	Hilgardite	boracite	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1		
131	9.3.31	5/K.06-20	30374	22	p	1	Tunellite																				
132	9.3.31	5/K.06-20	30375	22	p	1	Tunellite																				
133	9.3.31	5/K.06-20	30376	22	p	1	Tunellite																				

Example: Pyrite

DP	%DP
Corrosion	11%
Tarnish	86%
Efflorescence	23%
Powder	7%
Crumbling	21%
Flaking	5%
Breakages	9%
Cracks	56%
Dull	78%
Dark	57%
Colour Change	33%
# of Specimens	1,274

Exploratory

- 1st Order: Surficial Ox.
- 2nd Order: Ox. at Depth

Principal Components

1. Physical Forces
2. Tarnish only
3. Limonitisation
4. Pyrite decay

↳ PCs 2 & 3 = Surficial Ox.
↳ PCs 4 = Ox. at Depth

% of Variance

1. 22.560
2. 14.422
3. 12.408
4. 9.504

Pattern Matrix[a]

	Component			
	1	2	3	4
Crumb Crumbling	0.824			
Crack Cracks	0.702			
Break Breakages	0.474			0.404
Dull Dull		0.841		
Tarn Tarnish		0.782		
Dark Dark		0.751		
Corr Corrosion			0.844	
CC Colour Change			0.767	
Flake Flaking				0.669
Powd Powder				0.643
Efflor Efflorescence				0.486

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.[a]

a. Rotation converged in 17 iterations.