

Digital Mineralogical Mapping of Rocks

What is the value of mapping the world one micron at a time?

Alan R Butcher

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Geological Survey of Finland
GTK

Some content courtesy of FEI-Thermo Fisher Scientific

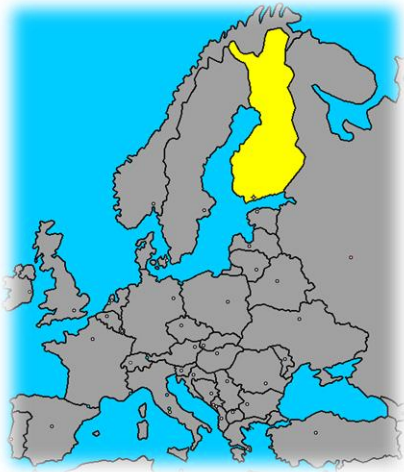


GTK
gtk.fi

What is the GTK?

Geologian Tutkimuskeskus

Geological Research Institute



GTK produces and disseminates geological information for the industry and society to promote systematic and sustainable use of crustal resources and the national geological endowment

Considerable resources remain undiscovered

Most of Finland's ore deposits have been discovered by GTK



Established in **1885** – 132nd year anniversary this May 2017

1835 - British Geological Survey

Only 4% of the Finnish bedrock is outcropping – the rest is covered by glacial till, sand, clay, moraines and lakes

Making Maps – since 1815

Scales of Observation During William Smith's time



From the air



On the ground



At the outcrop



Hand specimen



Cut and polish

Imagine if Smith had Access to the Digital Age?

Optical

Electron Beam

Ion Beam

X-ray Beam



1 cm

Great Oolite or Bath Freestone

Minerals

Textures

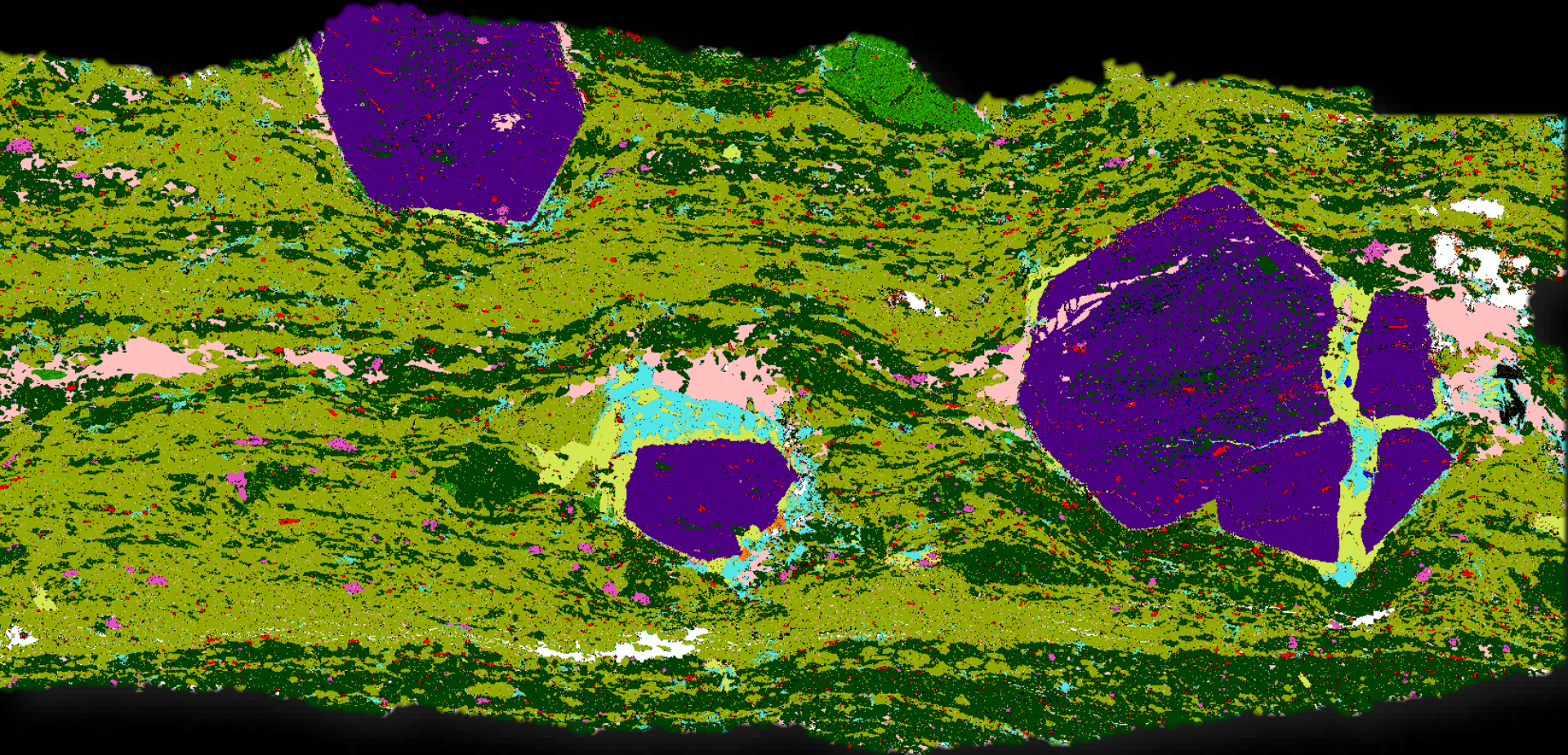
Quantification

Visualization

Mapping

Fossils + Rock Textures & Mineral Composition

Spatial Mineralogy Maps

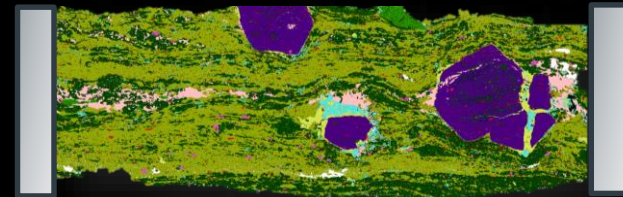


Garnet mica schist
QEMSCAN® image

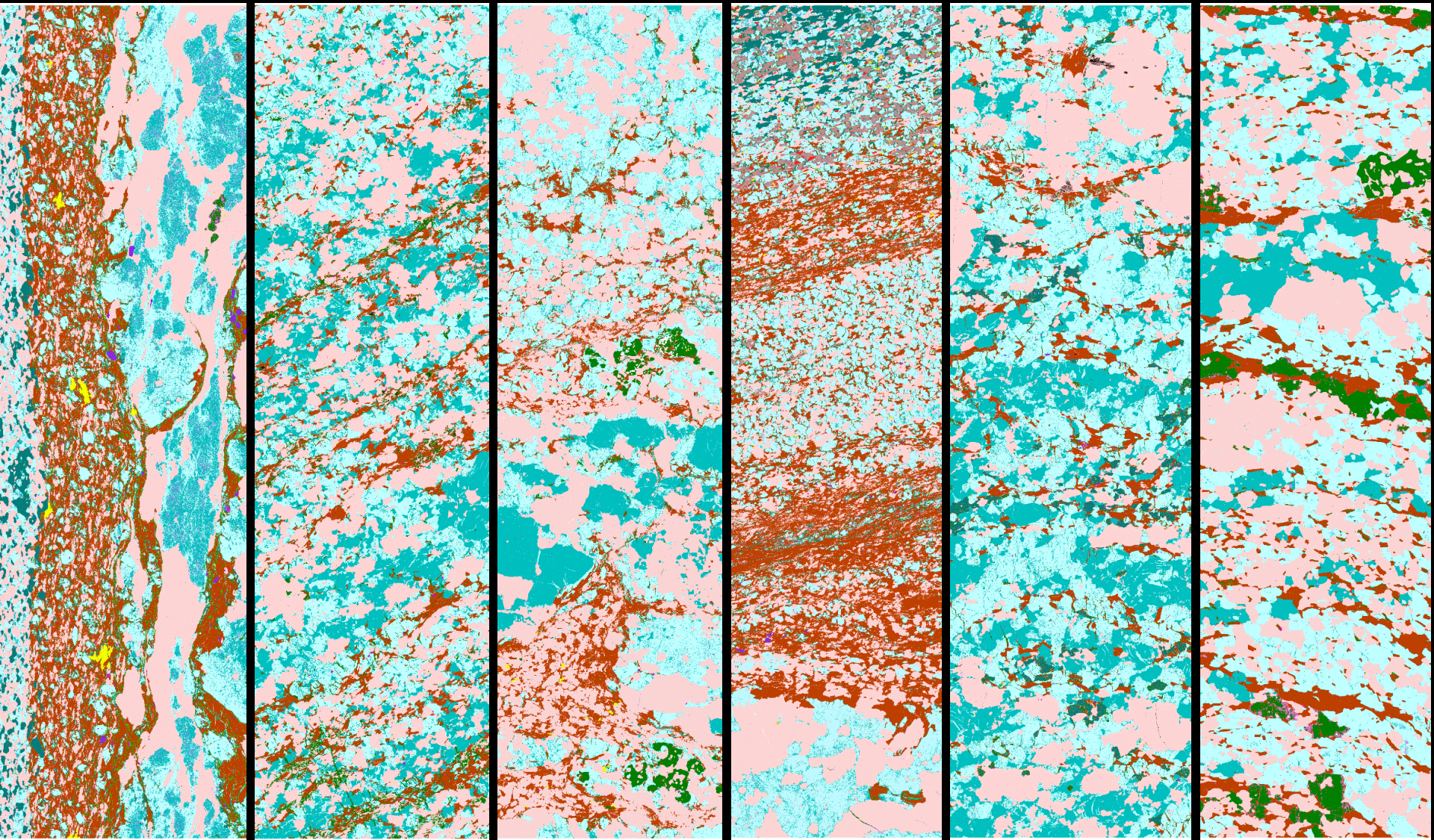
Image: Mike Garrick

Explore. Discover. Resolve.

1 cm



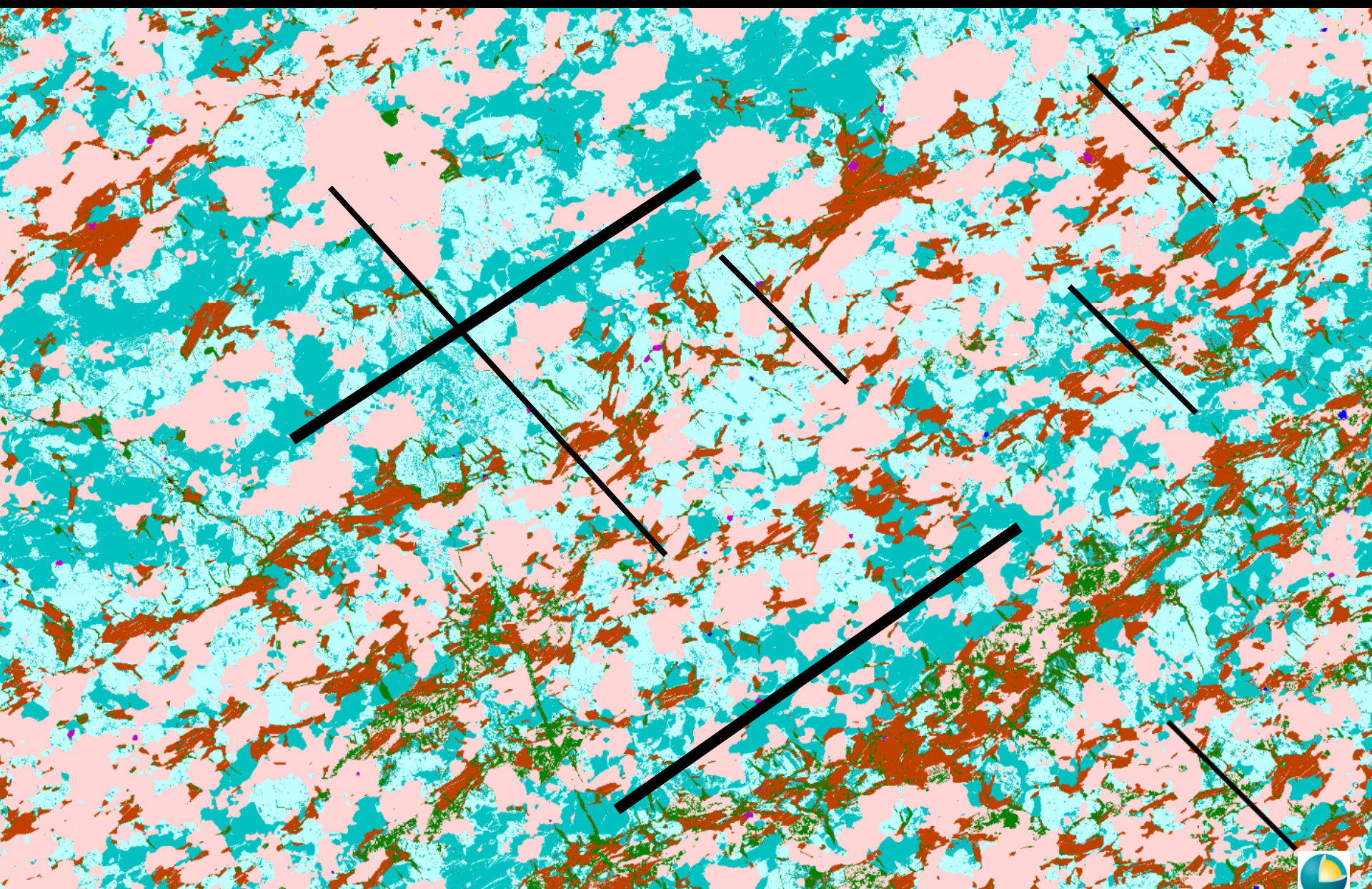
Finnish Migmatitic Montage



Collaborative project with Camborne School of Mines

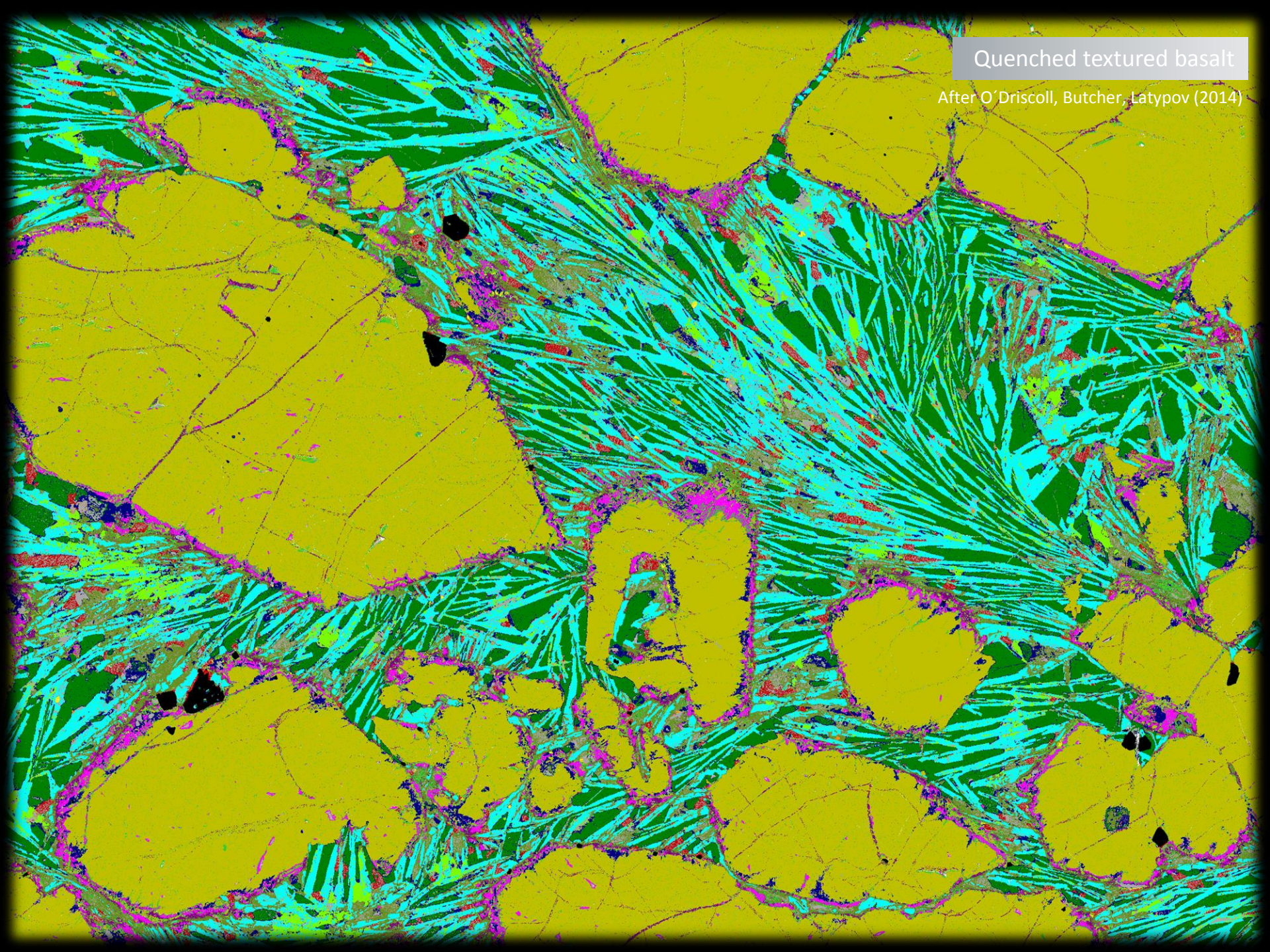


Two directional fabrics – one parallel to banding; one normal to banding



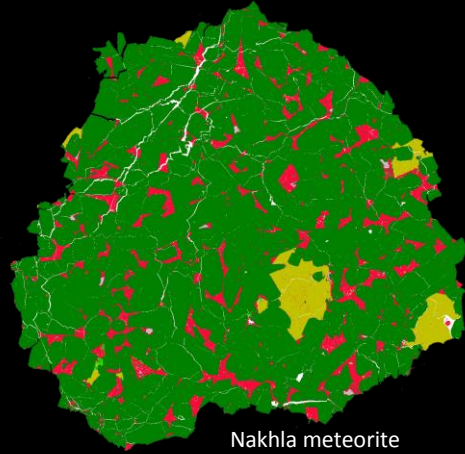
Quenched textured basalt

After O'Driscoll, Butcher, Latypov (2014)



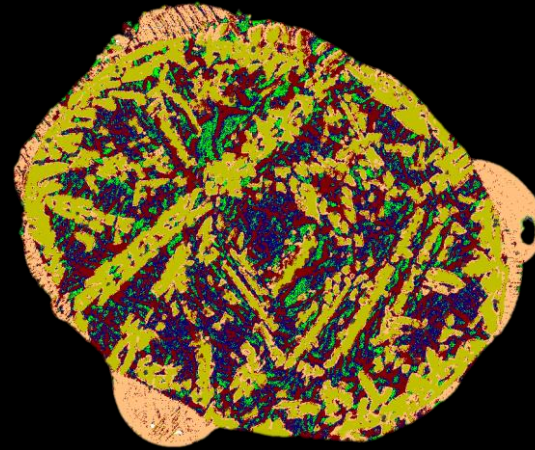
Mars, Moon, Earth, & an Asteroid

Mars



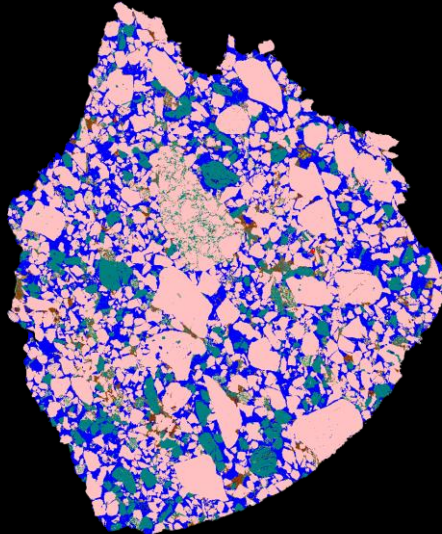
Nakhla meteorite

Moon



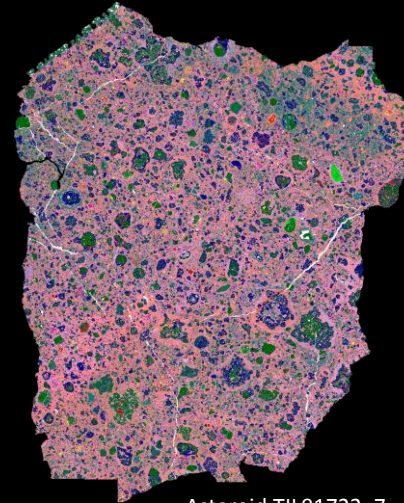
Apollo 17 Lunar regolith

Earth

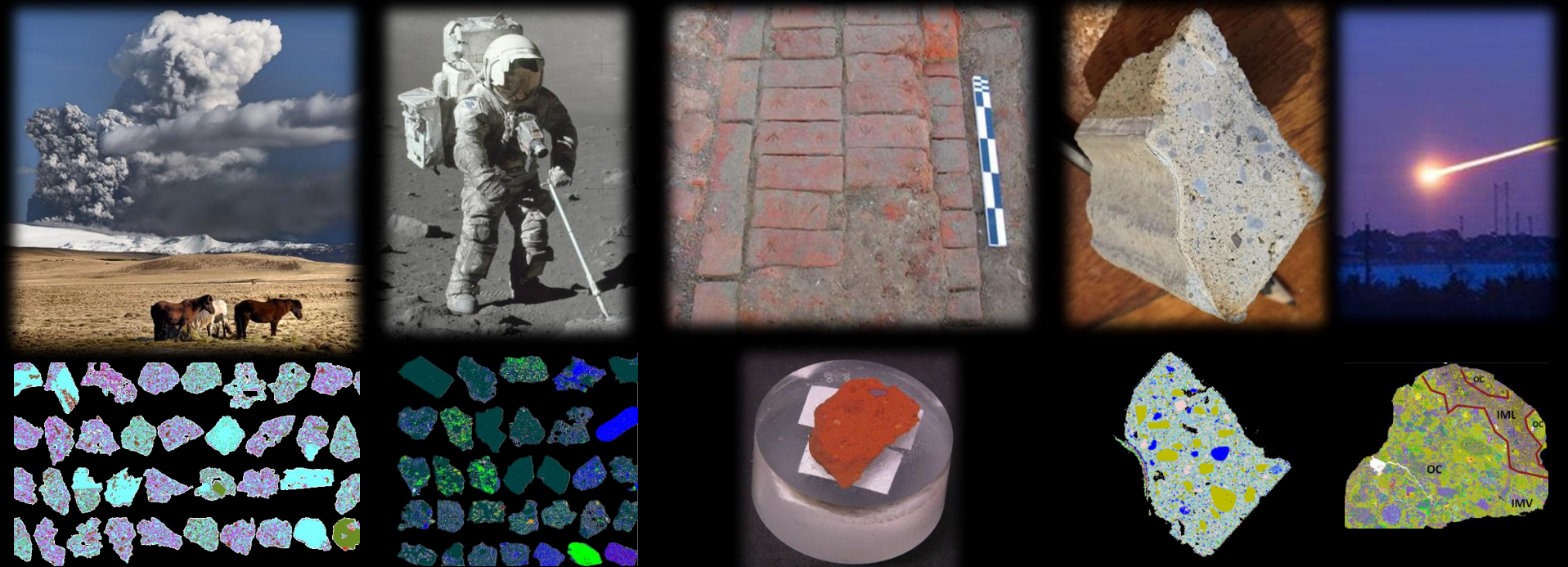


Basker 5 well

Asteroid



Asteroid TIL91722_7



Volcanic ash, lunar regolith, archaeology, historic buildings, meteorites, soil, crime scene investigations, urban mining



Explore. Discover. Resolve.

Back to William Smith ... and making maps

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Ion Beam

X-ray Beam

Great Oolyte or Bath Freestone

1 cm

Minerals

Textures

Quantification

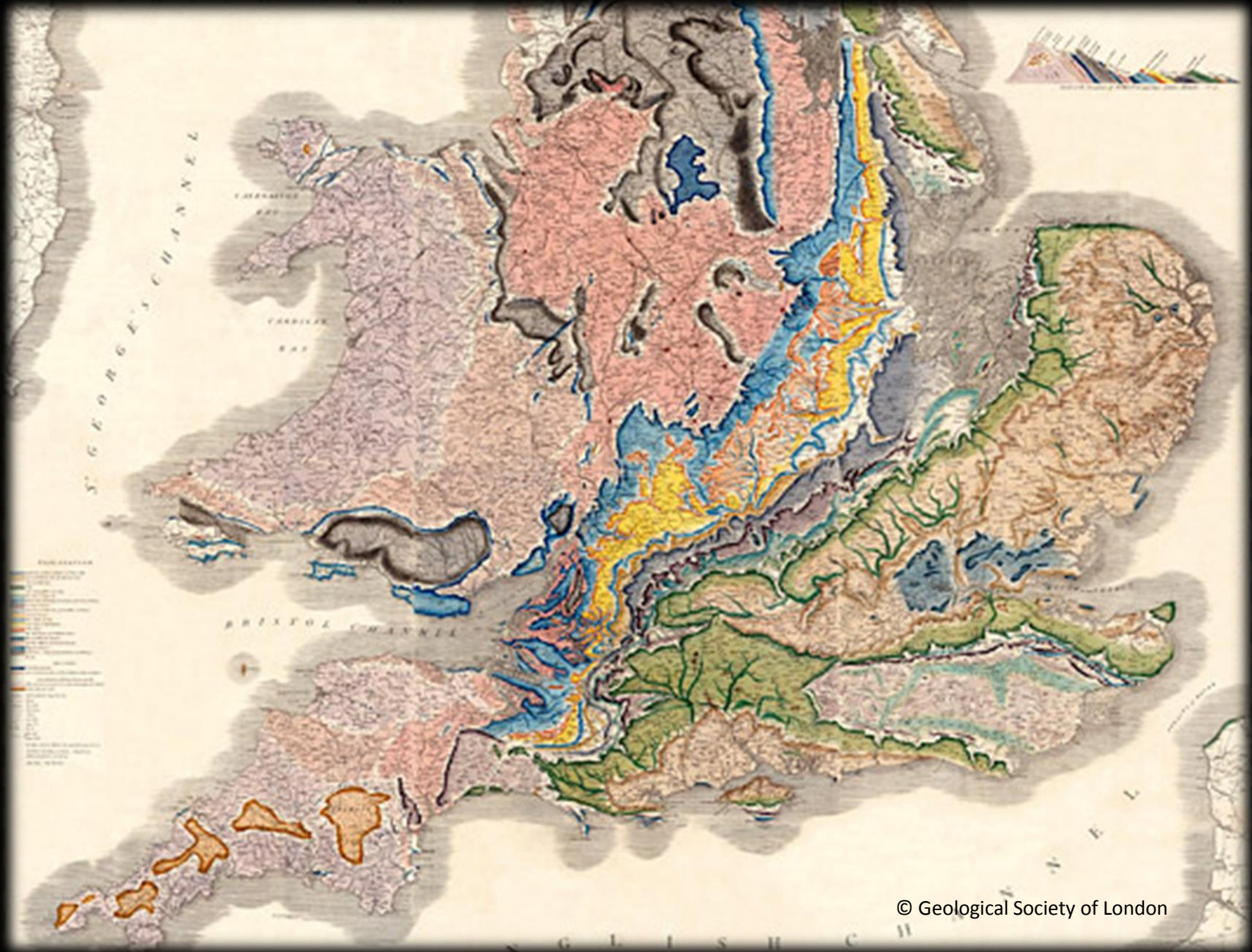
Visualization

Mapping

Fossils + Rock Textures & Mineral Composition

Celebration of the 1815 William Smith Map





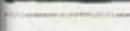
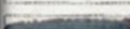


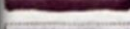
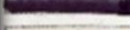














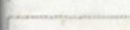
First geological map of an entire country



Celebration of the 1815 Map and List of Strata

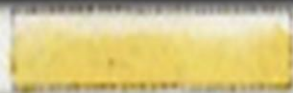
This Talk

EXPLANATION.

- 1  London Clay of Harrow, Highgate and Shooters Hills .
- 2  Clay and Brickearth, with some Sand and Gravel .
- 3  Sand and light Loam .
- 4  Chalk .
- 5  Green Sand, parallel to the Chalk .
- 6  Blue Marl, or Oaktree Soil .
- 7  Purbeck Stone, Kentish Rag, and Limestone of the Vale of Pickering .
- 8  Iron Sand or Carstone .
- 9  Clunch Clay and Shale, Vales of North Wilts and Bedford .
- 10  Cornbrash Limestone .
- 11  Forest Marble and Clay .
- 12  Great Oolite, or Bath Freestone .
- 13  Under Oolite .
- 14  Blue Marl Pastures of the Midland Counties .
- 15  Blue and White Lias Limestones .
- 16  Red Marl, Millstone and Brecciated Limestone .
- 17  Magnesian Limestone .
- 18  Coalmeasures—Penant paving Grindstones and Millstones .
- 19  + + + + The Coal .
- 20  resting on Sandstone .
- 21  Derbyshire Limestone .
- 22  Red and Dunstone, Brecon and the South Eastern Part of Scotland .
- 23  various alternations of Hardstone, Limestone and Slate .
- 24  Killas and Slate of Cornwall, Devon, Wales, Westmoreland, and Scotland .
-  Granit, Sienite and Gneiss



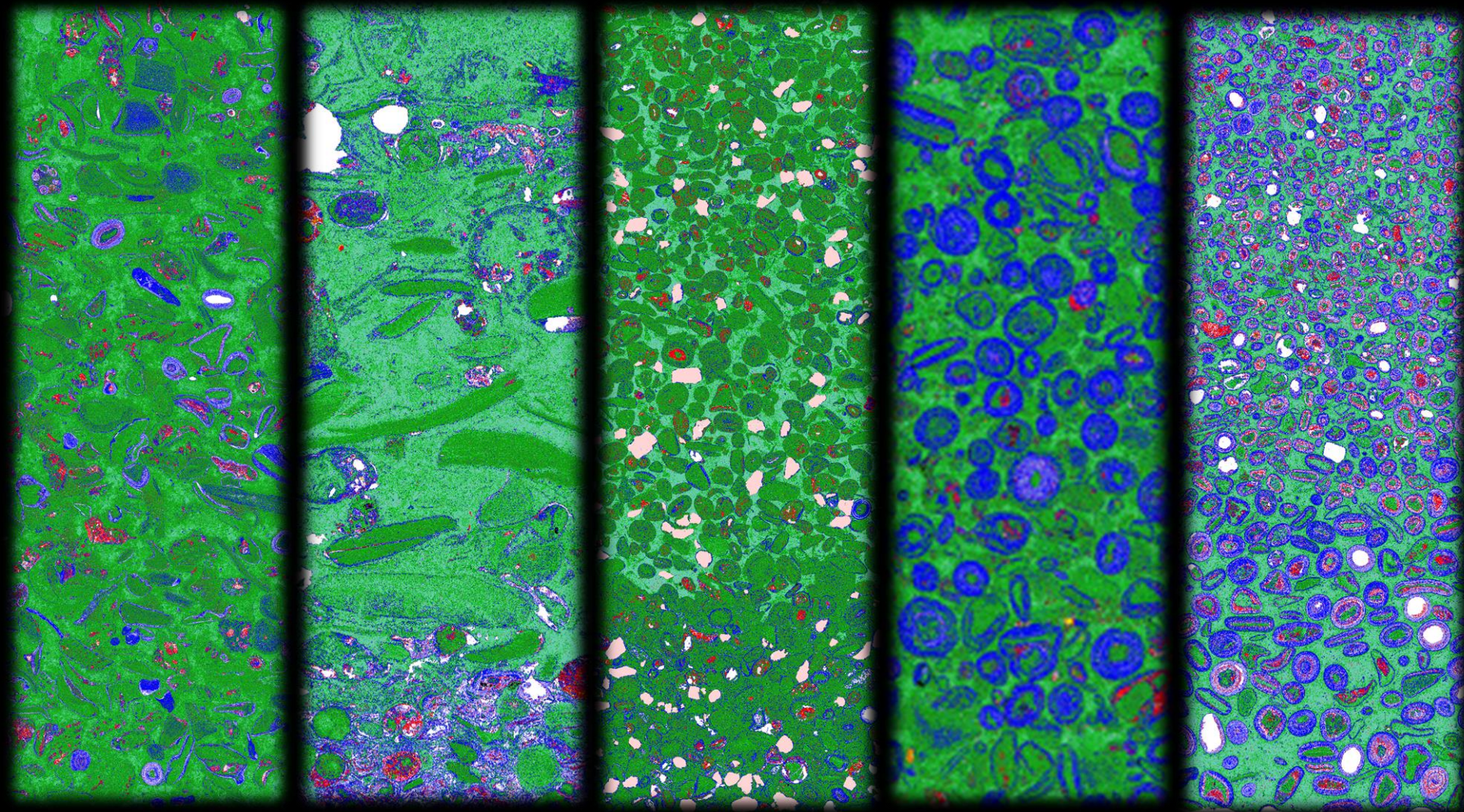
12.



Great Oolite, or Bath Freestone .

Images courtesy of Gavyn Rollinson, CSM

Limestone Petrofabrics



Oolith growth history



Bedding



Grain size variations



Cements & Pores

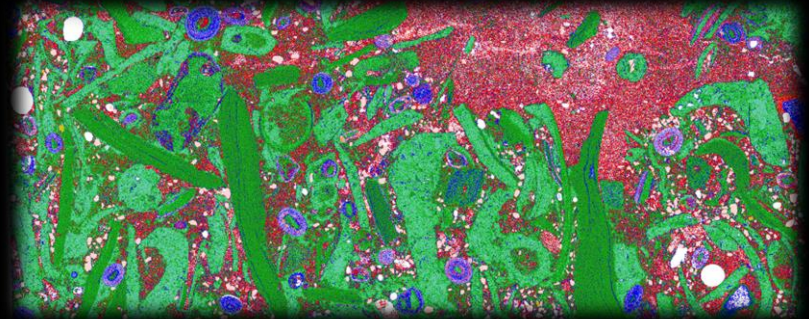
Digital Re-mastering of Smith's Stratigraphy

Smith's Order of Strata - Brought Alive

Middle Jurassic 175-165 my

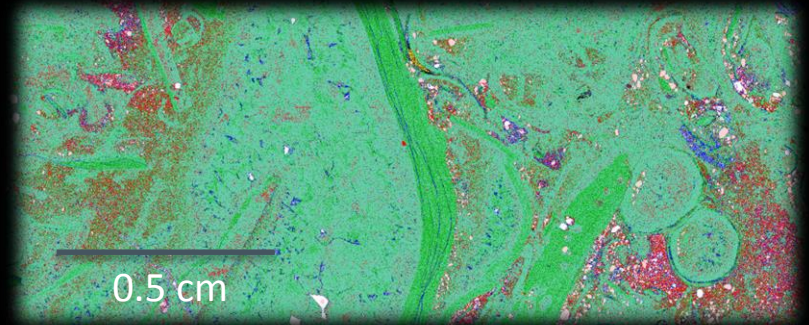
Digital Mineral and Texture Maps

10.

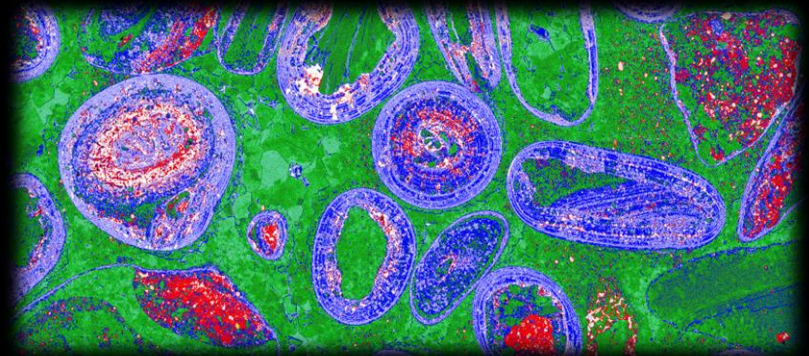
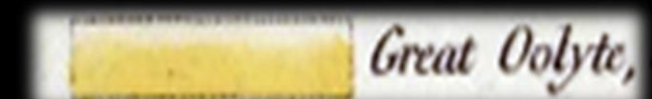


Images courtesy of Gayn Rollinson, CSM

11.



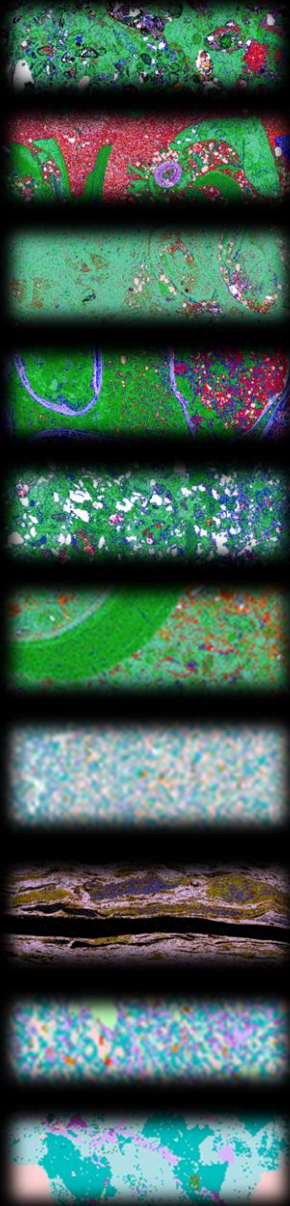
12.



Automated SEM-EDS

Smith's Stratigraphic Column – Digitally Remastered

Images courtesy of Gavyn Rollinson, CSM



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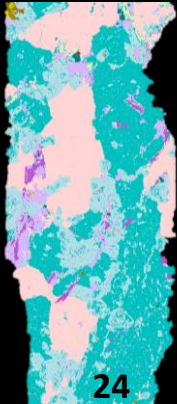
	<i>London Clay of Harrow, Highgate and Shooters Hills .</i>
	<i>Clay and Brickearth, with some Sand and Gravel .</i>
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	<i>Granit, Sienite and Gneiss .</i>

William Smith Digital Rock Project

Industrial Relevance Lives on in 2D & 3D!



Ore bodies



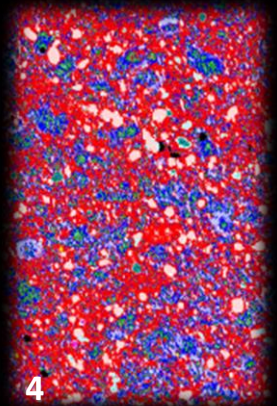
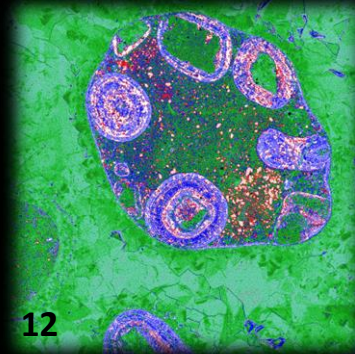
Combustion



Building stones

23

Reservoirs



Industrial minerals

Kiitos!

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