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IRISH CENTRE FOR RESEARCH
IN APPLIED GEOSCIENCES

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Innovative Approach to the Assessment of Road Aggregates

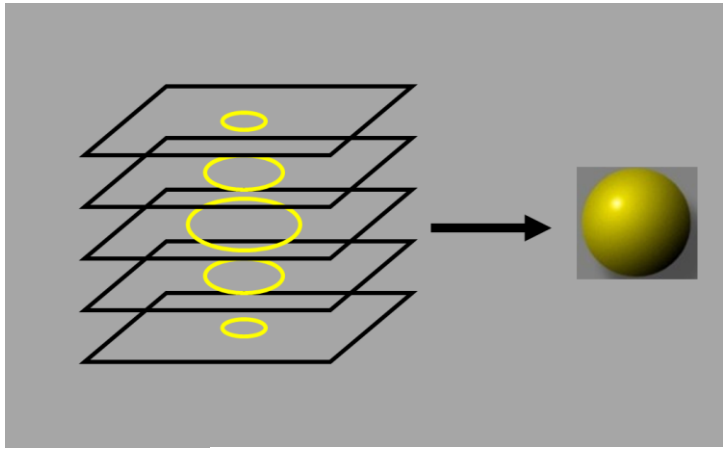
Petrographic and Metrological Analysis

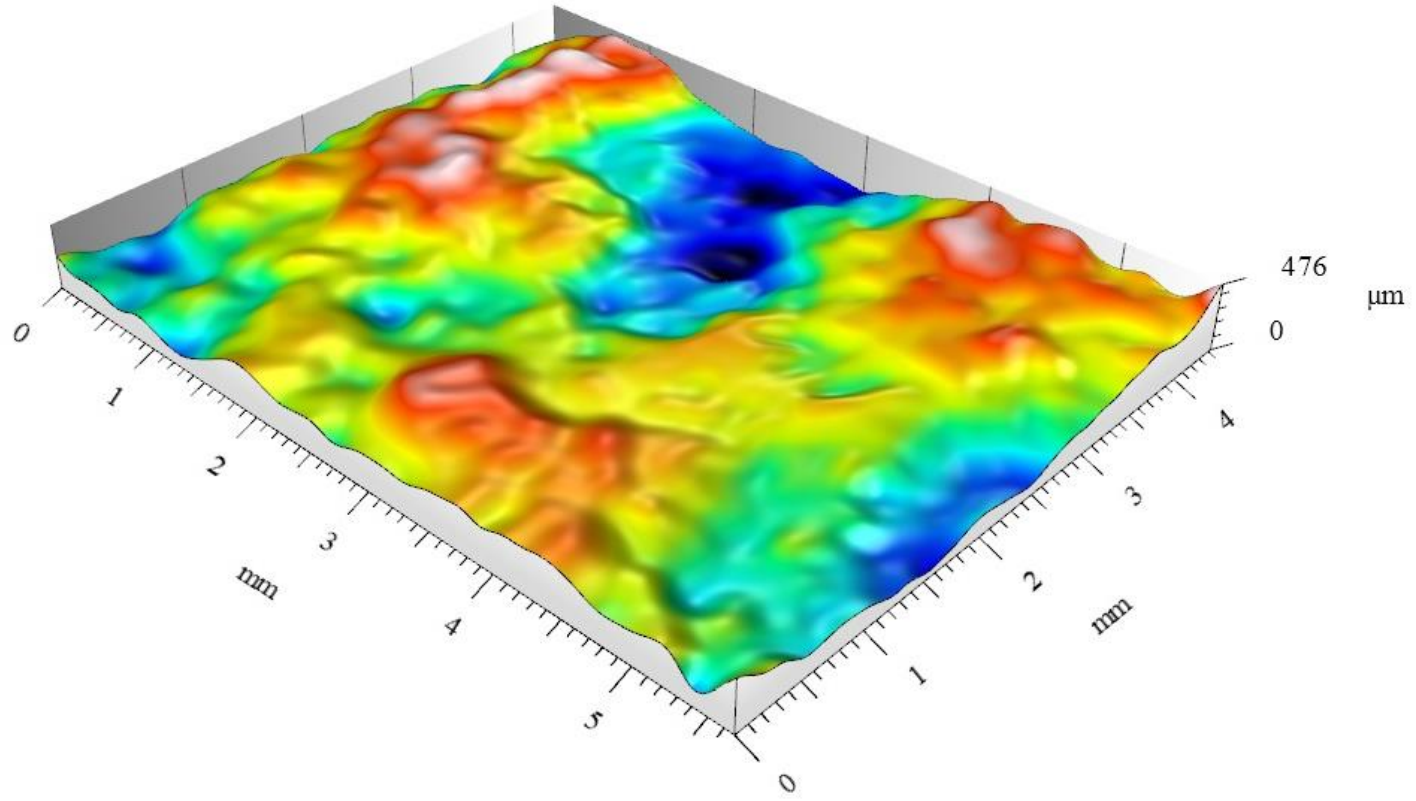
- Follow the product from quarry to laboratory to end-use in road surface course.
- Measure microtexture (roughness) of aggregate particles
- Examine, microscopically, the mechanisms that cause aggregate particles to wear and weather.
- Develop ‘fingerprints’ to ensure traceability of aggregates.

Providing reliable quantitative measurement of microtexture

- 2D profiles of aggregate chippings not enough
- 3D areal surface texture
- Roughness (ISO 25178)
- Digital Microscope
- Leica Map Software

Focus Stacking – Z-stacking





S_q - Root mean square height of the scale-limited surface

- $S_q = \sqrt{\frac{1}{A}\iint_A z^2(x,y)\mathrm{d}x\mathrm{d}y}$ = Roughness
- Measurement in microns (µm)
- Can be measured from:
  - freshly crushed aggregate
  - aggregate artificially polished in the laboratory
  - aggregate in road-core

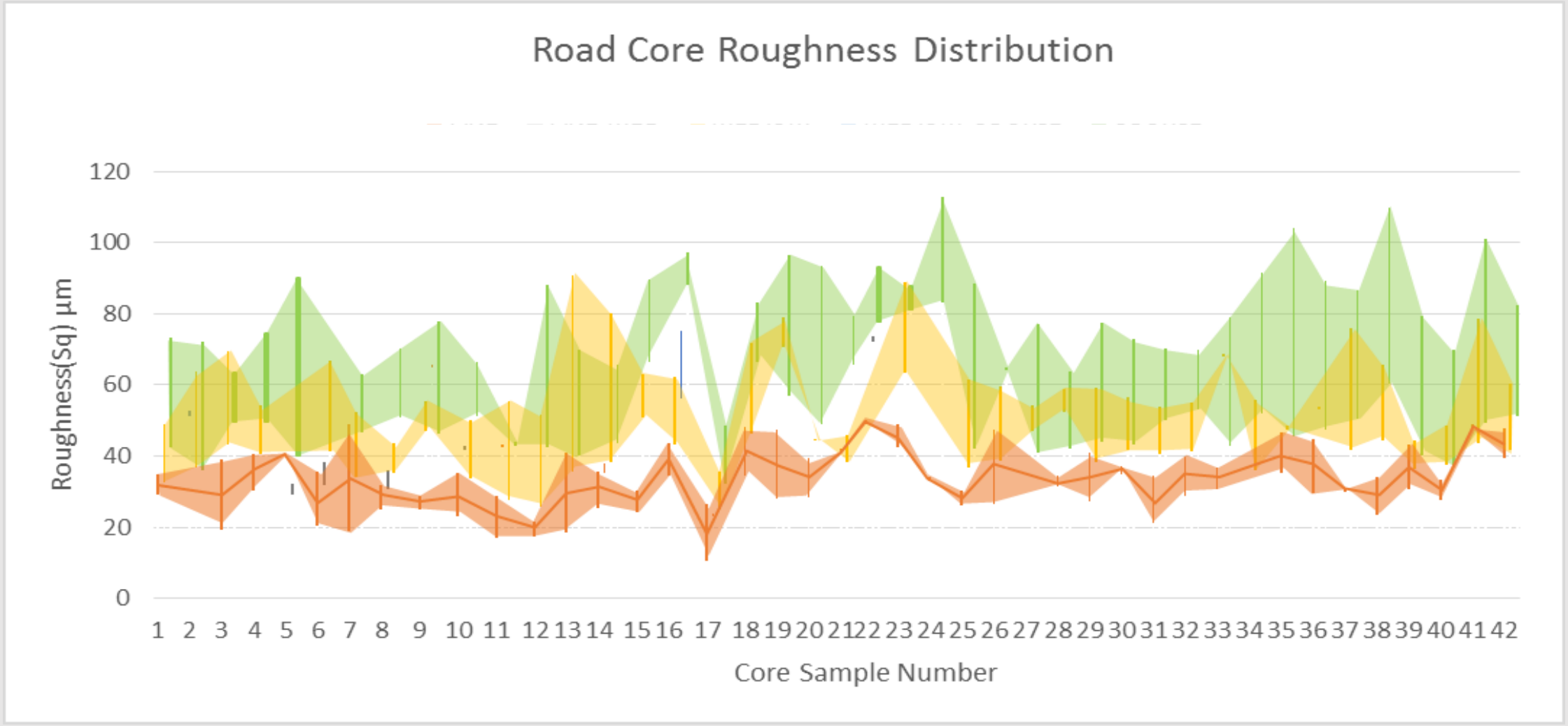
Road Core

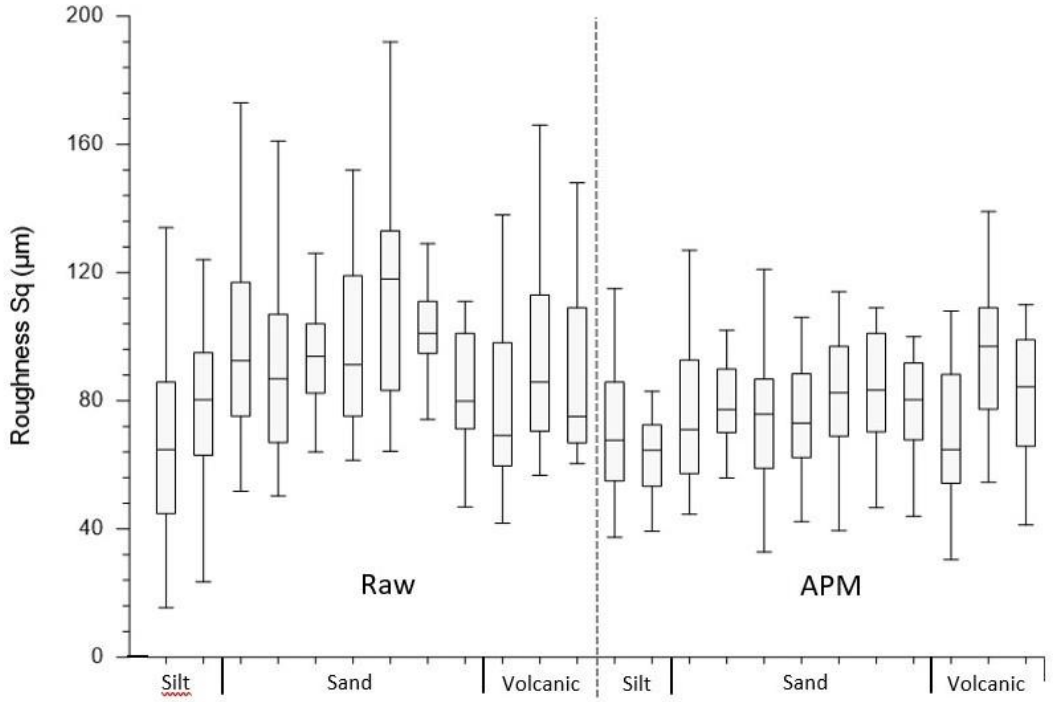
HRA + PCC

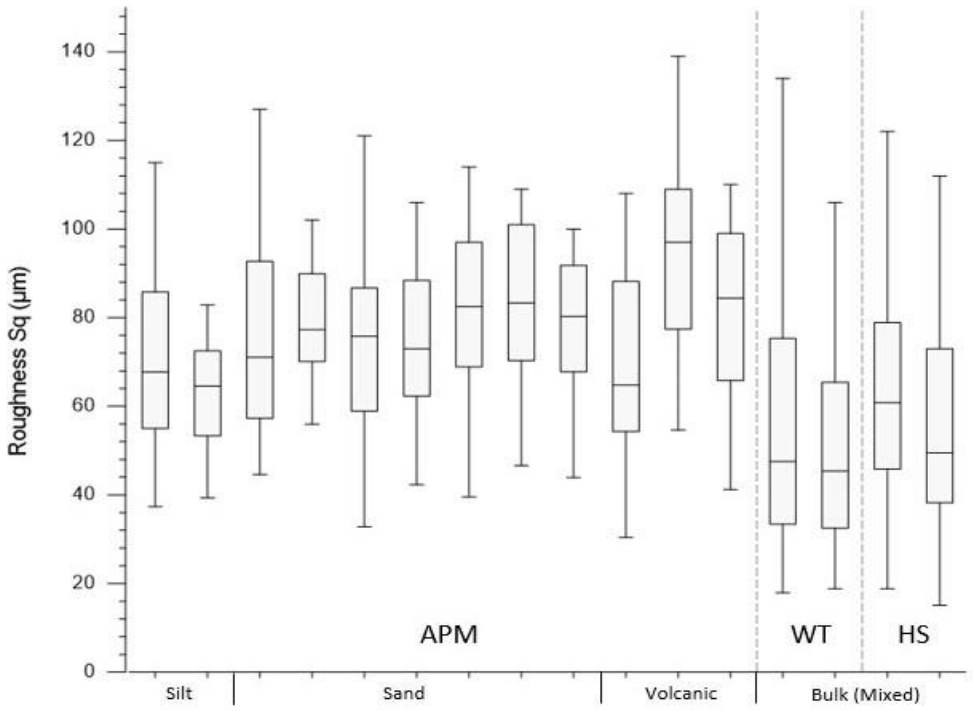
PMSMA

Roughness Measurement

- Aggregate particles mapped for each core ‘cap’
- Visible petrography using a stereomicroscope – grain-size, colour, identifiable minerals
- Transferred to digital microscope
- Each particle measured in a specified field-of-view
- Large topographical differences (concave/convex) removed
- Remaining height variation = roughness


Road Core Roughness Distribution
Roughness(Sq) µm
120
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
Core Sample Number

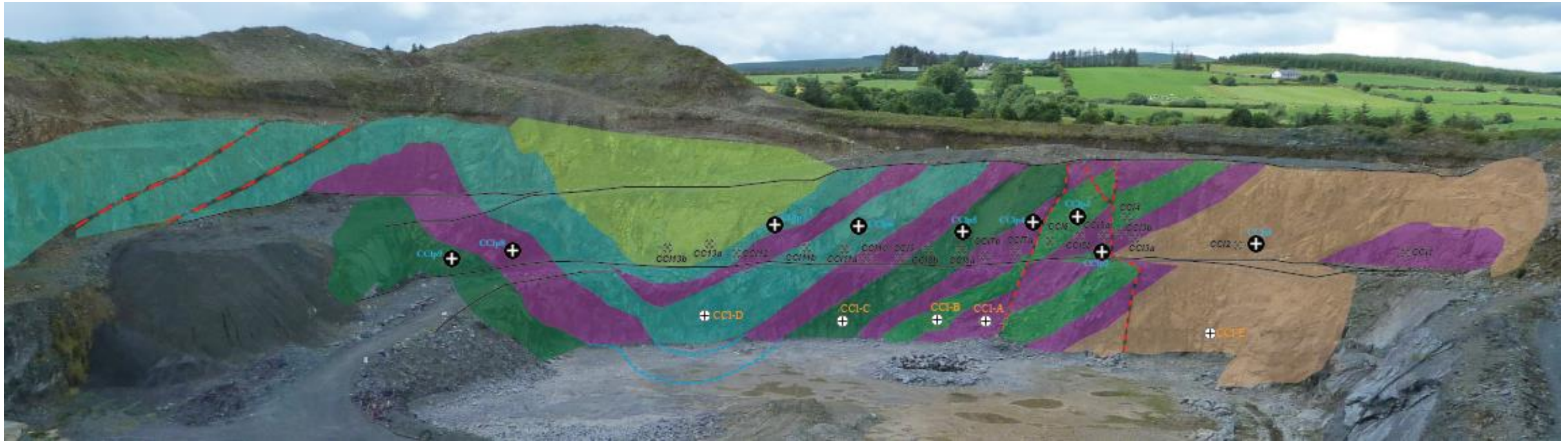




Experimental Work

Major Factors Controlling Aggregate Microtexture (Roughness) and Durability

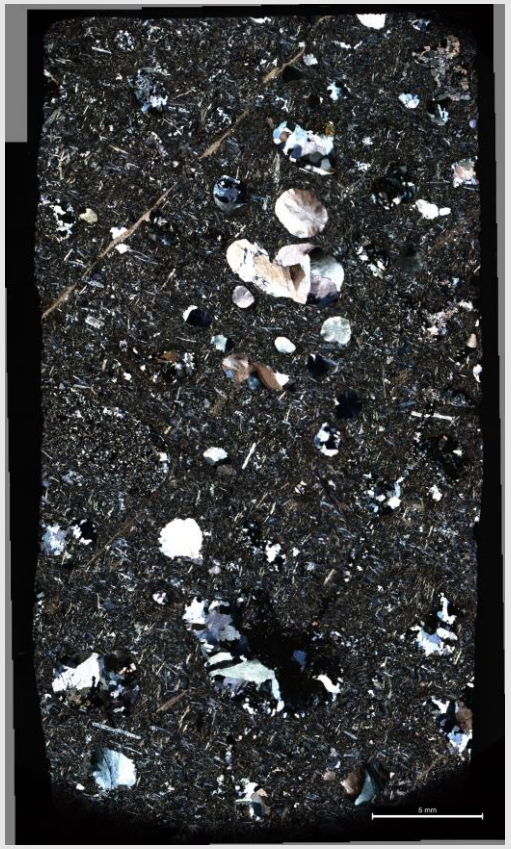
- Grain-size
- Mineralogy
  - Main minerals present
  - Distribution of ‘matrix’
- Micro-structure
- Induration/fluid infiltration
- Degree of weathering

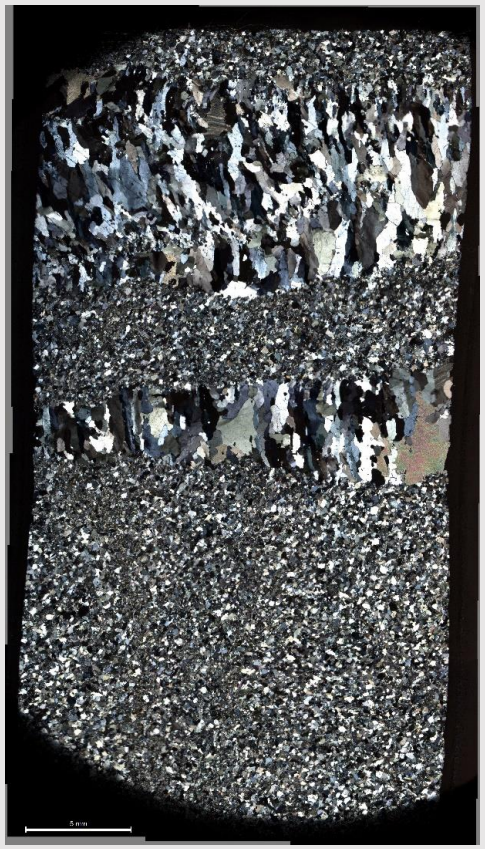


Quarry Face Mapping

Lithology

Structure + Fluid Infiltration

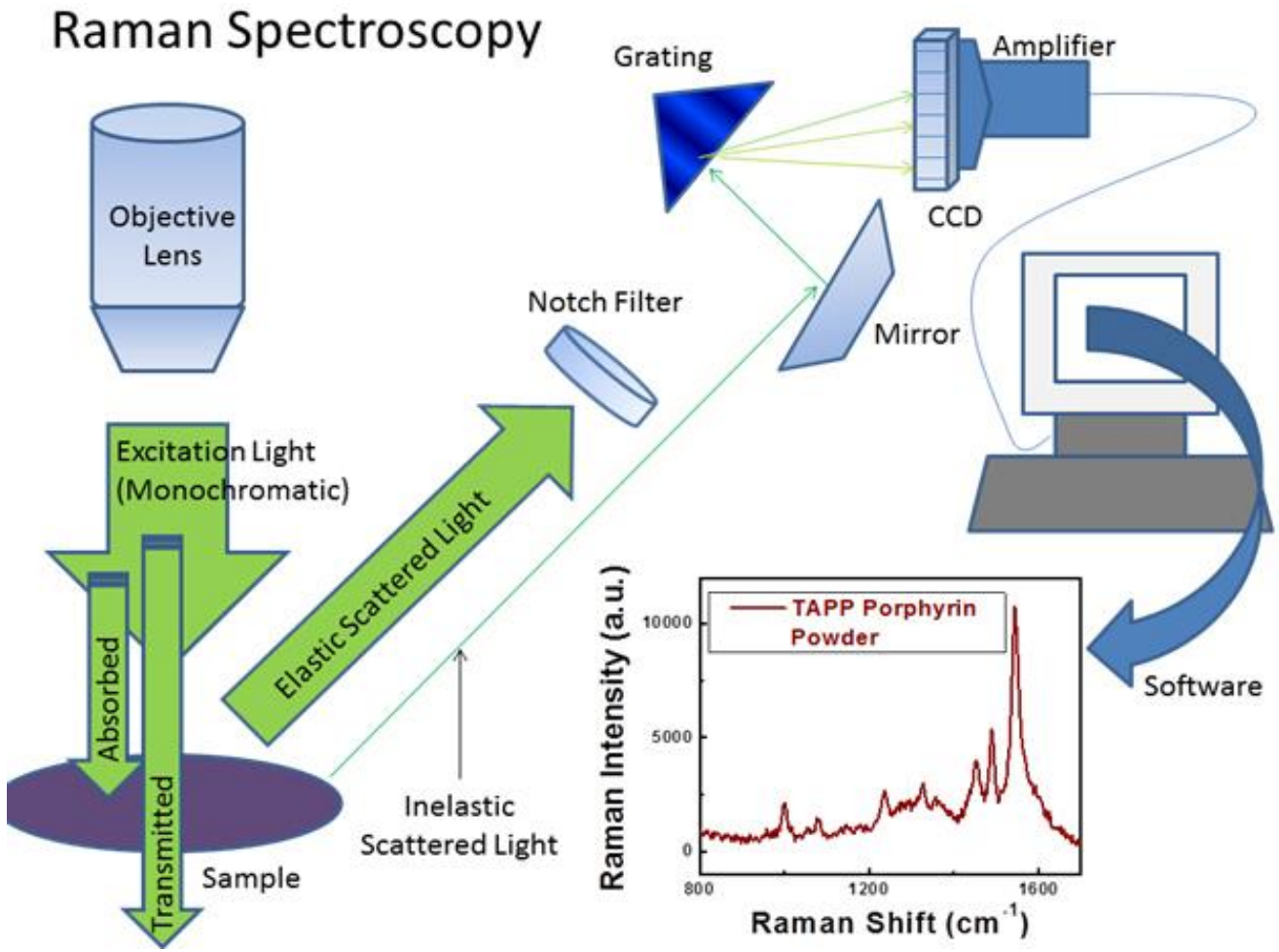


Hand Samples and Thin Sections

Raman Spectroscopy

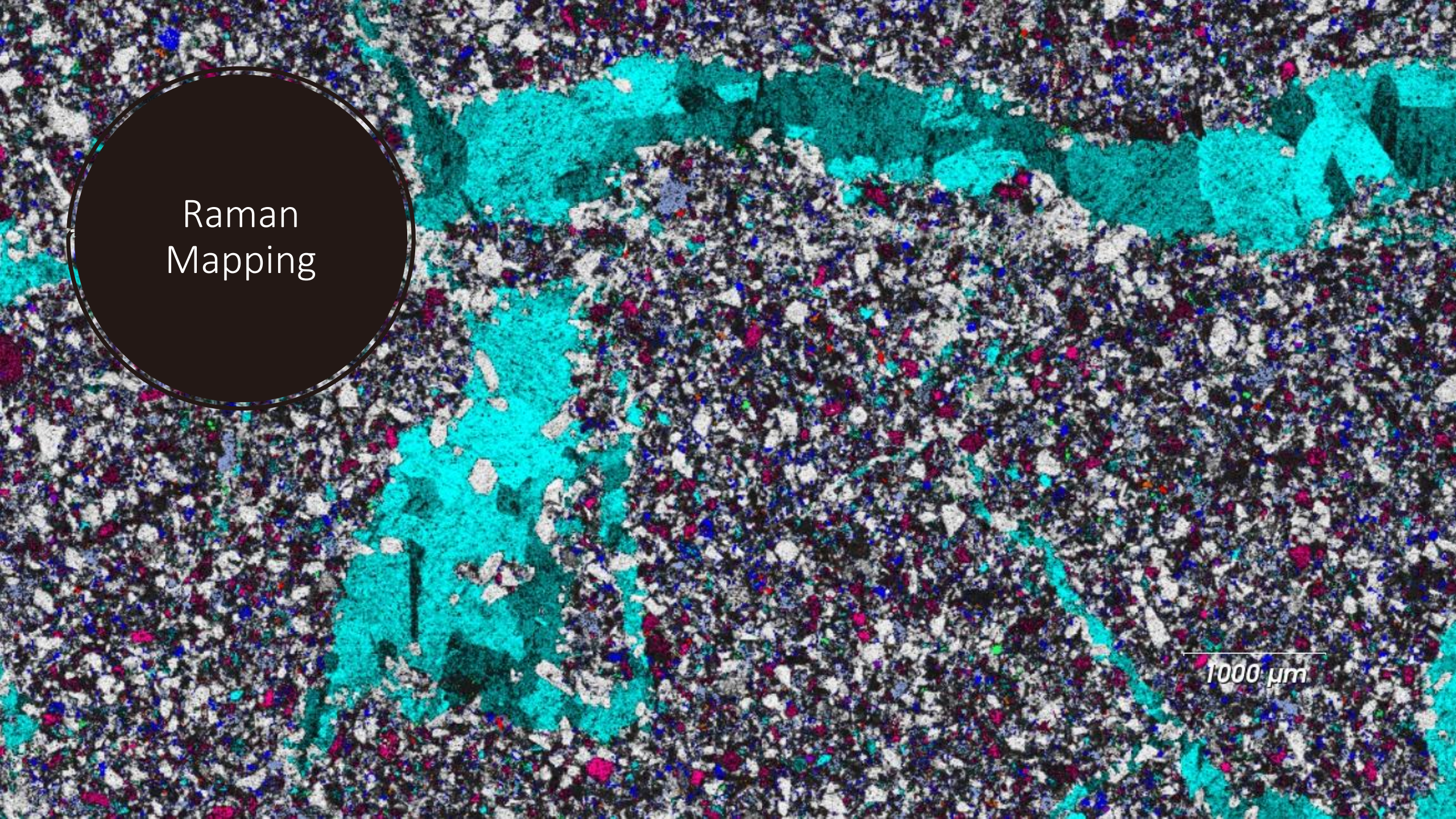
- Raman Spectroscopy – expose mineral to a light source of specific wavelength (laser). The light interacts with molecular vibrations causing a shift in the energy of the laser photons and is recorded as a spectra.
- Generate mineral maps of thin sections and aggregate particles



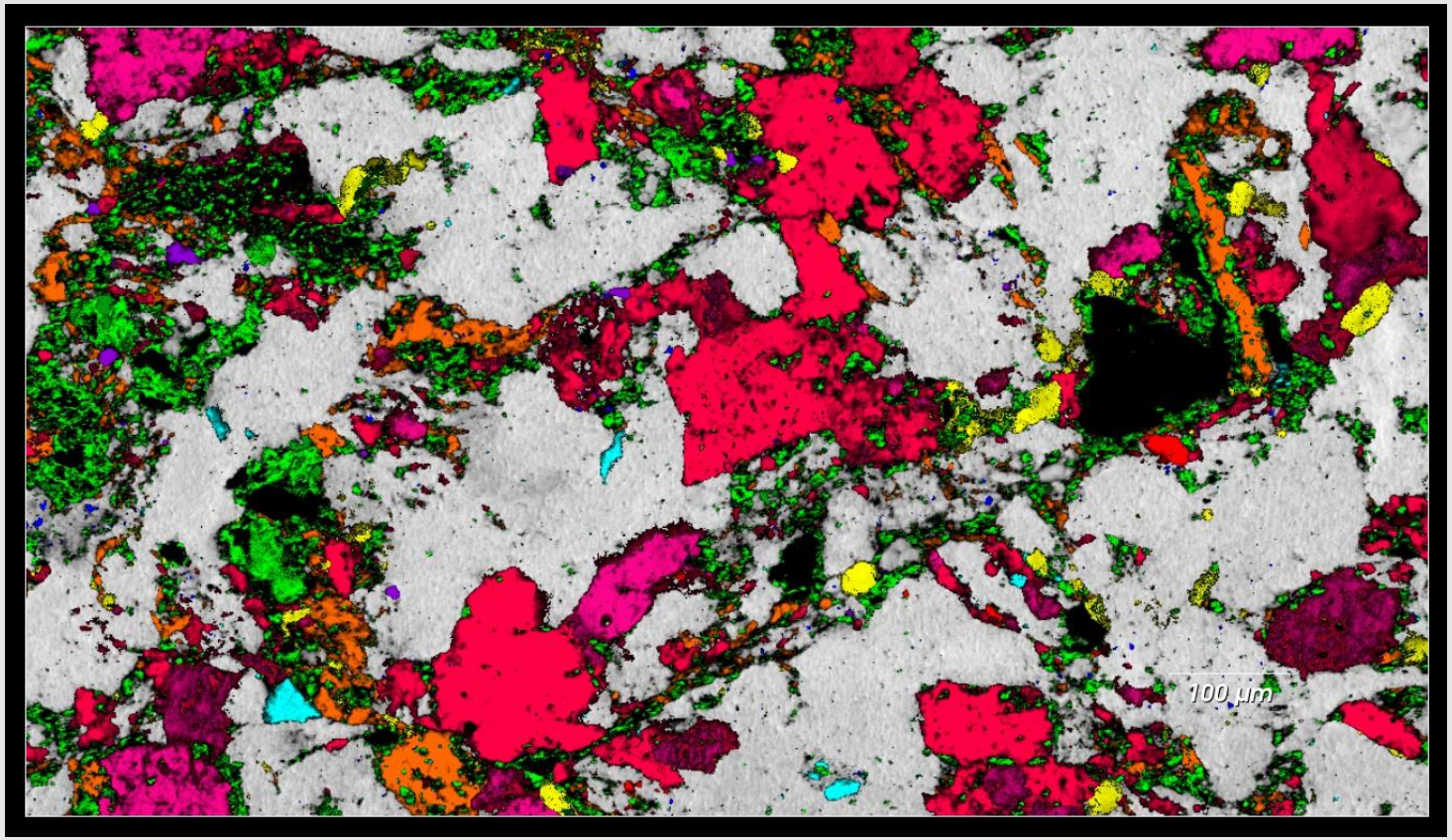
Equipment

- Map rough, uneven, and curved surfaces
- Little or no sample preparation is required
- View Raman chemical images in 3D and see both the chemistry and the topography

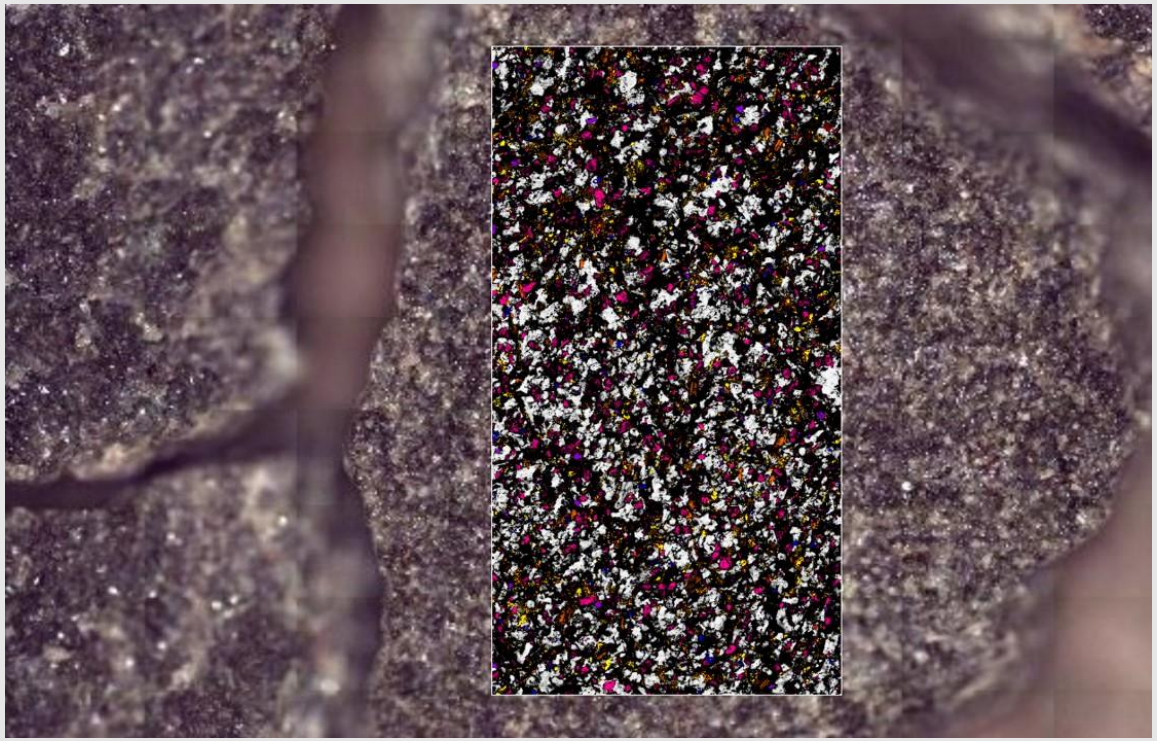
Raman Mapping

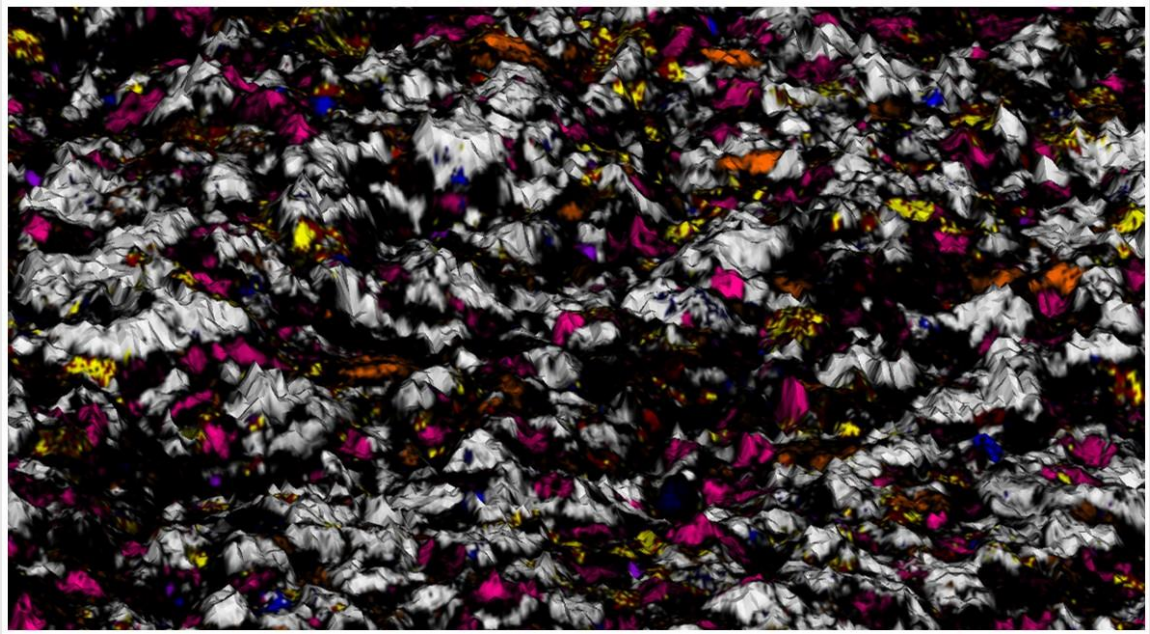


Understanding Mineralogy and Grain Relationships



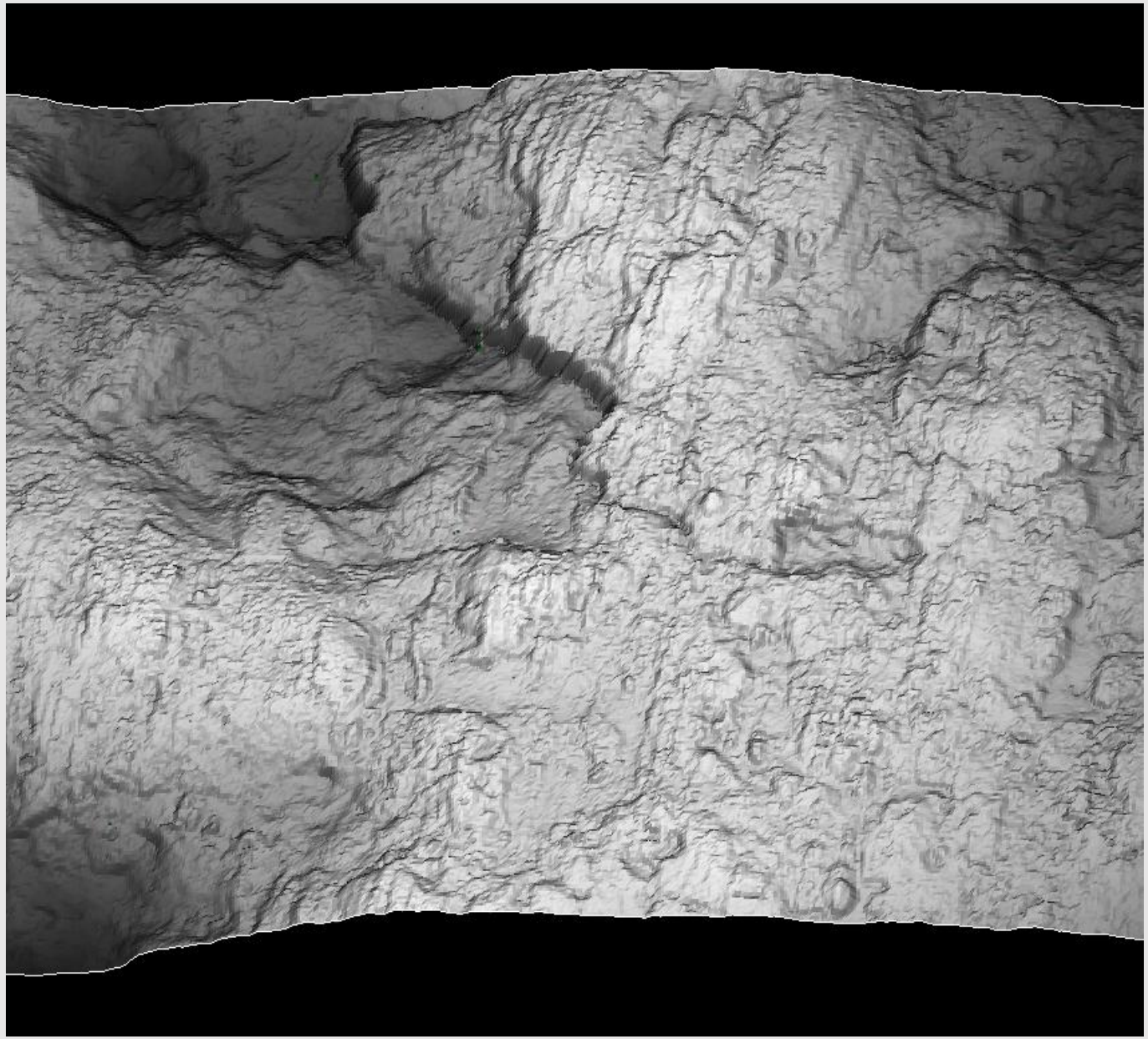
3D Imaging





Laser Generated Topographic Maps

Provide detailed information on the microtexture (roughness)



Research Output

- Generate database of aggregates utilised in Ireland
  - Quarry samples
  - APM shoes
  - Road Core
- Develop model for ranking aggregates based on their petrography
  - Ability to maintain required roughness (microtexture) over predicted lifetime of surface
  - Durability – under load, chemical stability, resistance to freeze/thaw