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GeMMe Resourceful Engineers

ROCKePEDIA

Towards a shared intelligence platform to support computer-assisted rock identification

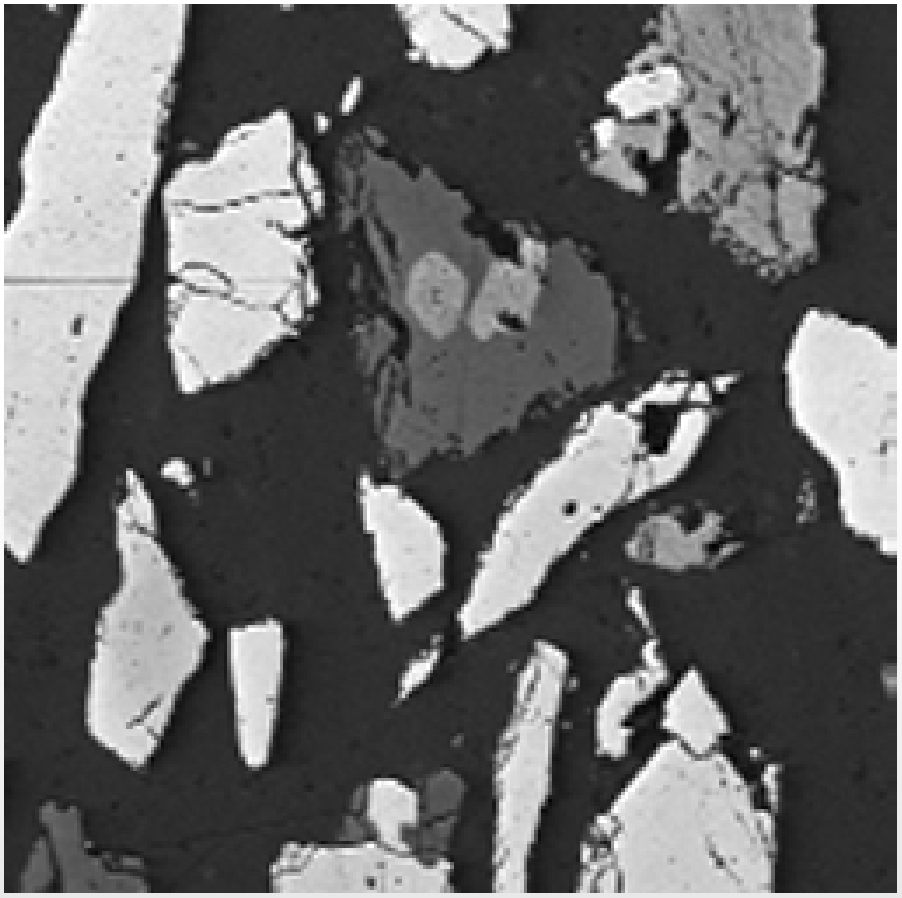
Eric PIRARD

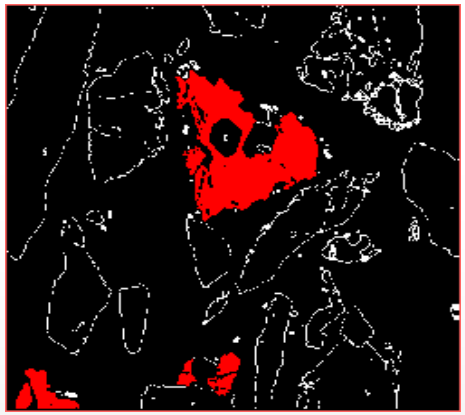
Bouzahzah H., Barnabé P.

Ever Better Pixels

Ever Better Pixels

- 1985 - Grey Levels
  - 512 x 512 x 8 bits
  - Thresholding
  - Erosion / Rebuild



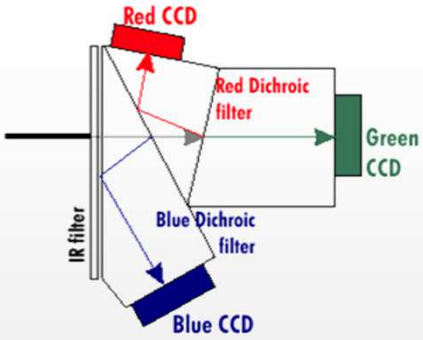


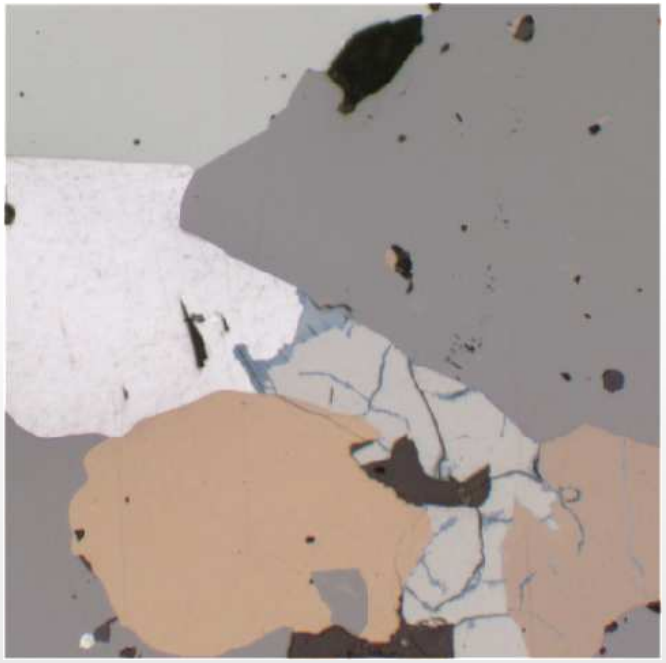
Panasqueira

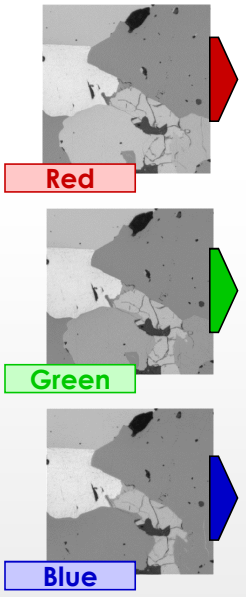
TT2 –Sulphide Concentrate

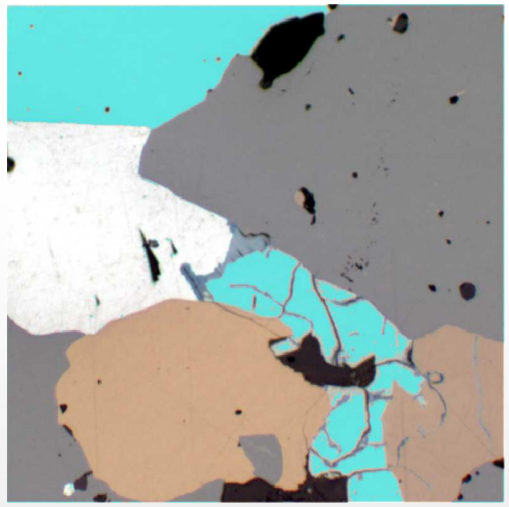
Ever Better Pixels

- 1991 - True colours
  - Shoe Box + PostProcess
  - 512 x 512 x 3 x 8 bits







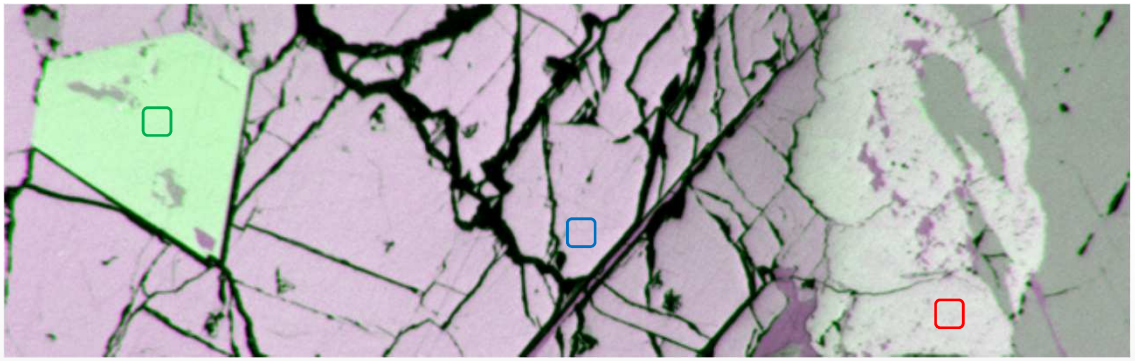


Kipushi

Bornite-Galena-Sphalerite

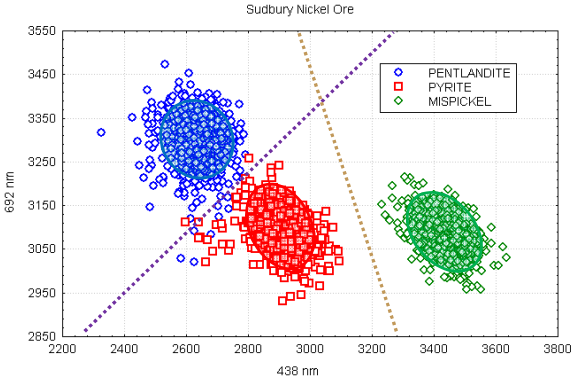
Ever Better Pixels

- 2000 – Multispectral Imaging
  - 1376 x 1040 x 12 bits x N bands

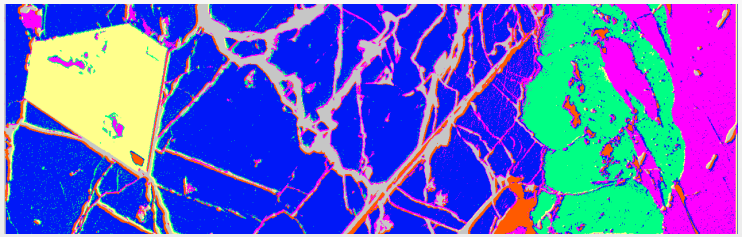


Sudbury

Cu-Ni sulphides



Optimal multivariate hyperplanes (linear combinations) to separate the three training sets



Result of MultiGaussian Maximum Likelihood classification using four bands (438nm-489nm-591nm-692nm)

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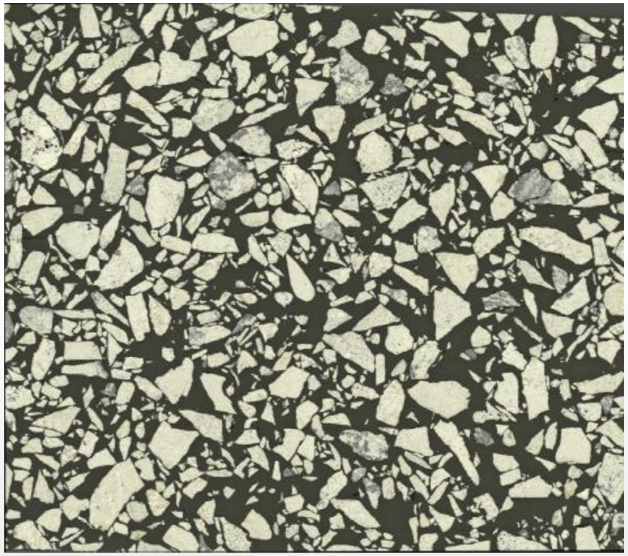
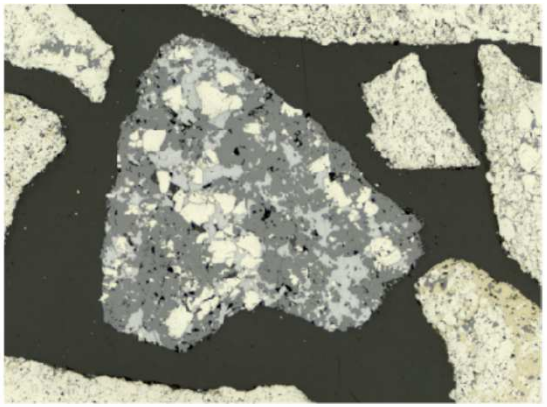
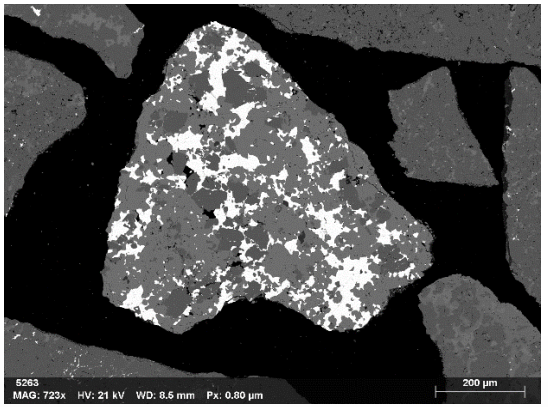
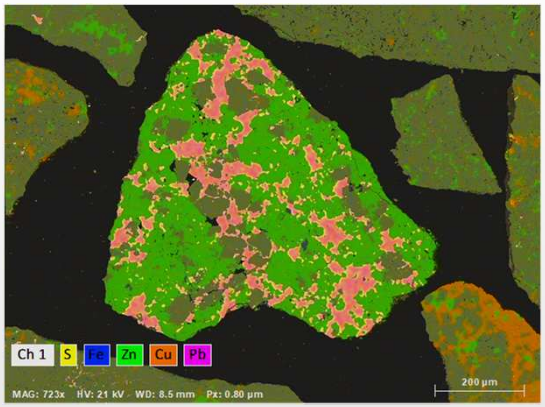
Ever Better Pixels

- 2020 – Multimodal Imaging
  - Gigapixel Images









Ever Better Pixels

- 2021 – Where do we stand ?
  - Mature Imaging Technologies
  - Widely accessible

  - Need to share
    - Best SAMPLE PREPARATION practices
    - Best SCIENTIFIC IMAGING principles

Sharing Pixels

Sharing Pixels

- Multiple generations of storage solutions
  - Floppy disk, magnetic tapes, zip disk, CD, mobile HDD, HDD racks, …
  - TIFF file format

- Scientific papers
  - Low quality reproduction
  - JPG compression in PDF
  - Original data not available to researchers

Minerals Engineering 137 (2019) 277–289

Contents lists available at ScienceDirect

Minerals Engineering

journal homepage: www.elsevier.com/locate/mineng

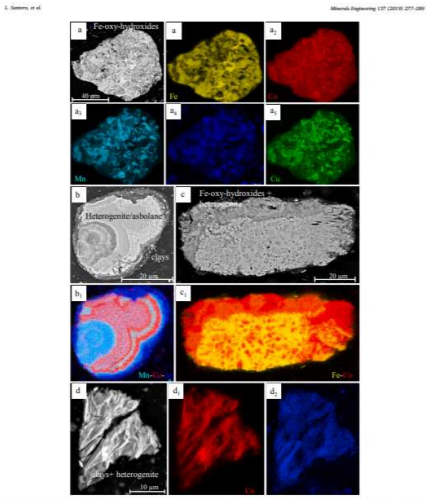
Mineralogical reconciliation of cobalt recovery from the acid leaching of oxide ores from five deposits in Katanga (DRC)

Licia Santoro, Steev Tshipeng, Eric Pirard, Hassan Bouzahzah, Arthur Kaniki, Richard Herrington

ARTICLE INFO

ABSTRACT

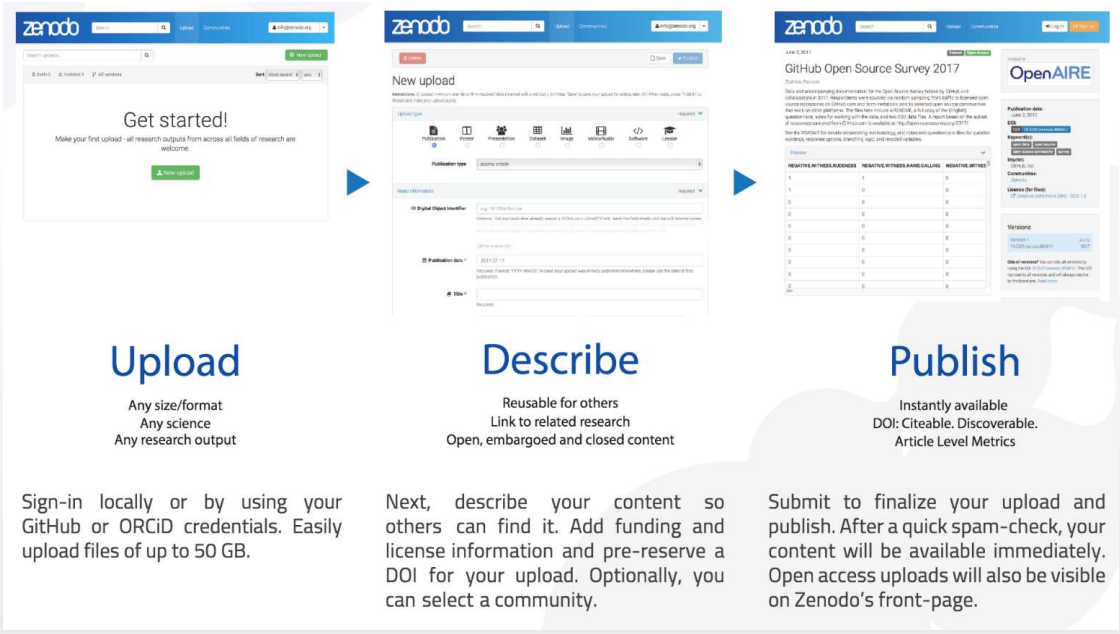
1. Introduction



Sharing Pixels

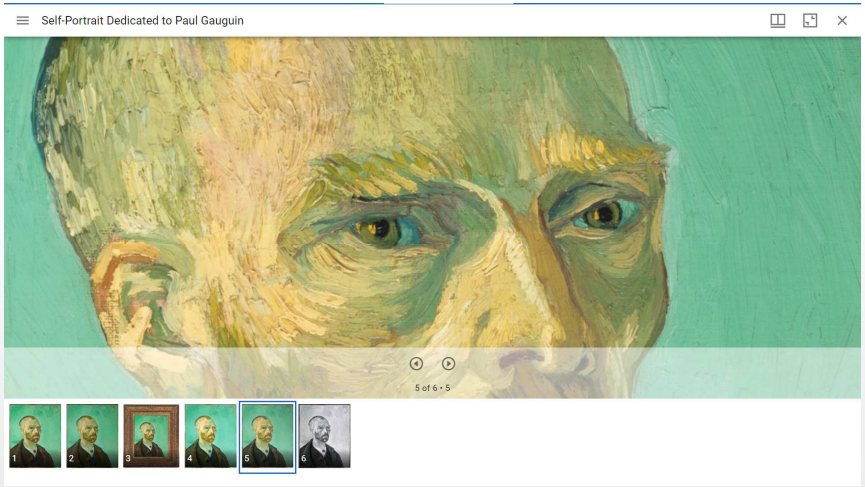
- Open Data / Open Science
  - https://www.openaire.eu
    - H2020 - Make data publicly available

  - ZENODO / DRYAD
    - Linking datasets to published papers
    - csv, text, xls,…



Sharing Pixels

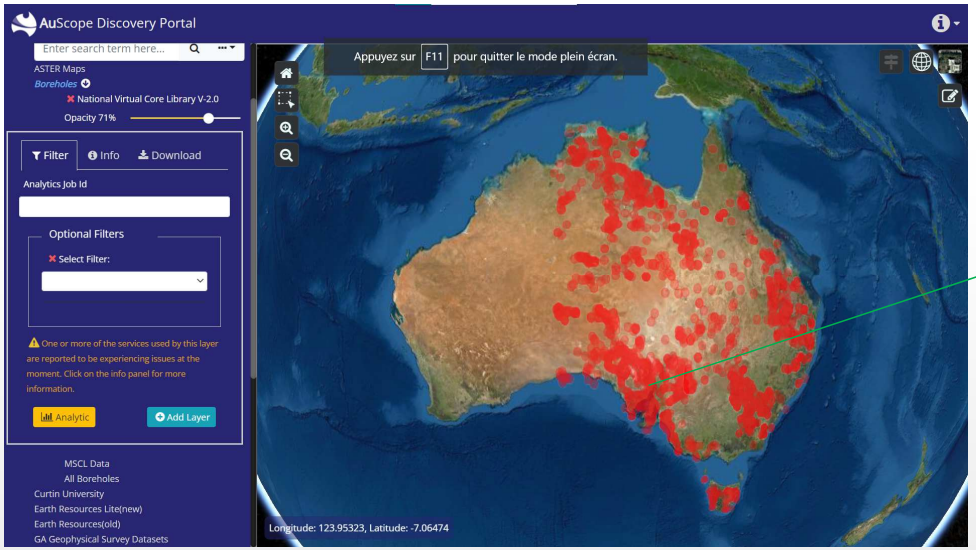
- Open Images
  - IIIF - International Image Interoperability Framework
    - Adopted by libraries and museums to visualise high quality images
      - ✓ Mirador, Micrio,…
    - Provides a shared environment in which both publishers and users can annotate the object

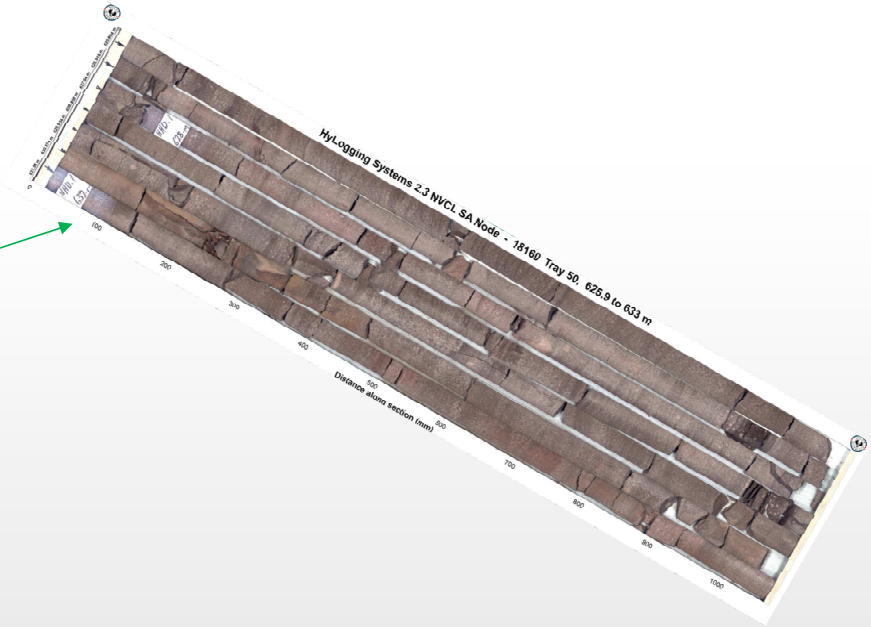


Mirador test site : https://mirador-dev.netlify.app/

Sharing Pixels

- Geological and Georeferenced Images
  - Auscope Portal – National Virtual Core Library v2.0
    - Geographic navigation
    - On-demand visualisation of core trays





http://portal.auscope.org.au/

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Sharing Pixels

- 2021 – Where do we stand ?
  - Open data is a growing trend
  - Online visualisation of scientific datasets
  - Available platforms for seamingly navigating Gpixel images

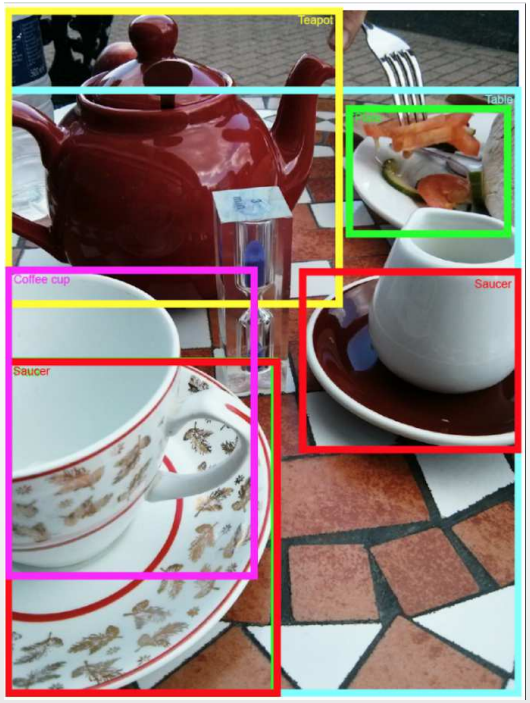
  - Need to improve
    - Adequacy to geological samples (Georeferencing, 3D,…)
    - Possibility for expert annotation

Actionable Intelligence

Actionable Intelligence

- Open Image DataSet v6
  - 9M images annotated with 36M image-level labels, 15.8M bounding boxes, 2.8M instance segmentations.
  - For training the latest deep convolutional neural networks for computer vision tasks

Civilization CC BY 2.0 *Paul Downey*



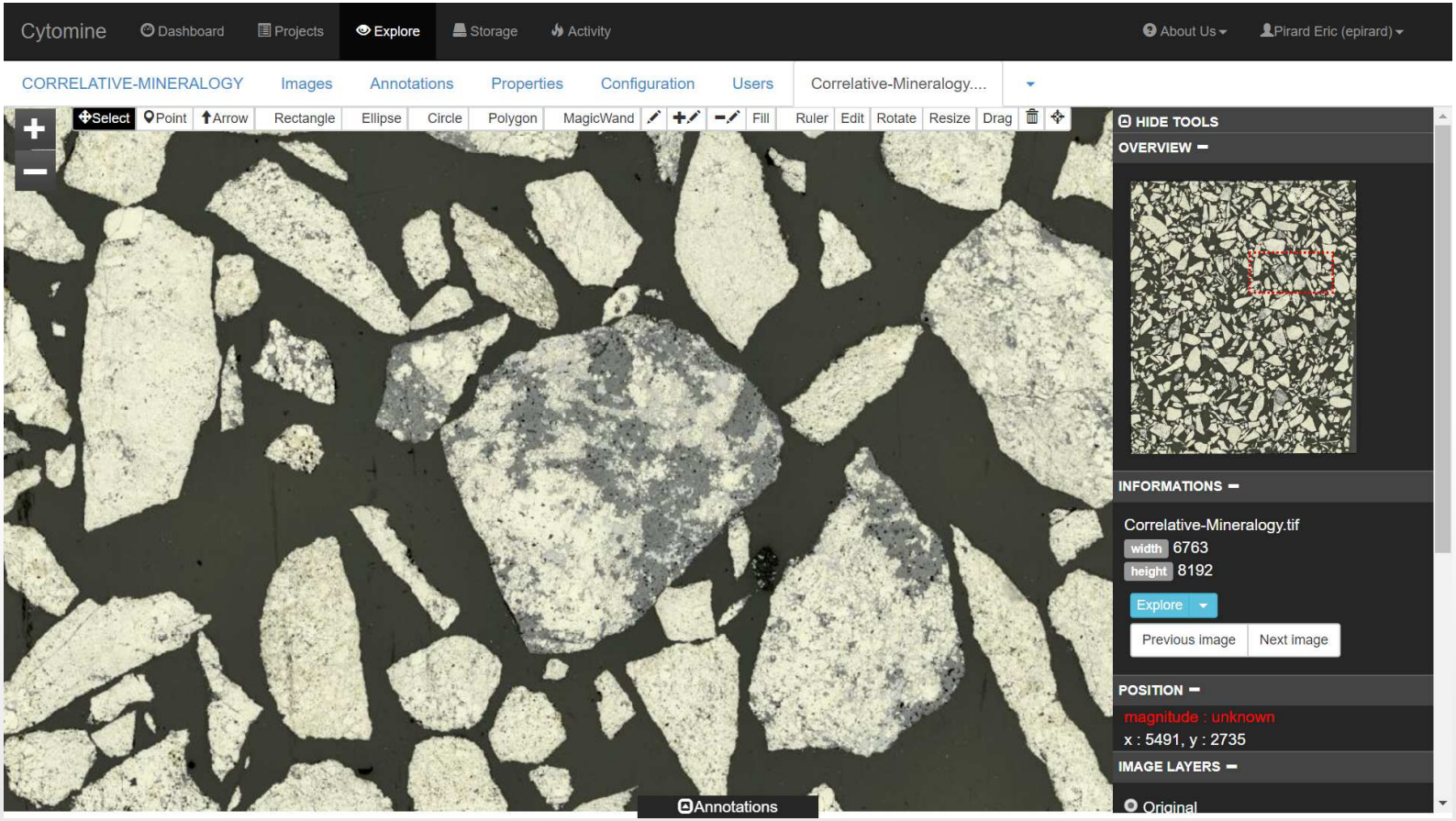
Labels generated by tens of thousands of users from all over the world at crowdsource.google.com

Actionable Intelligence

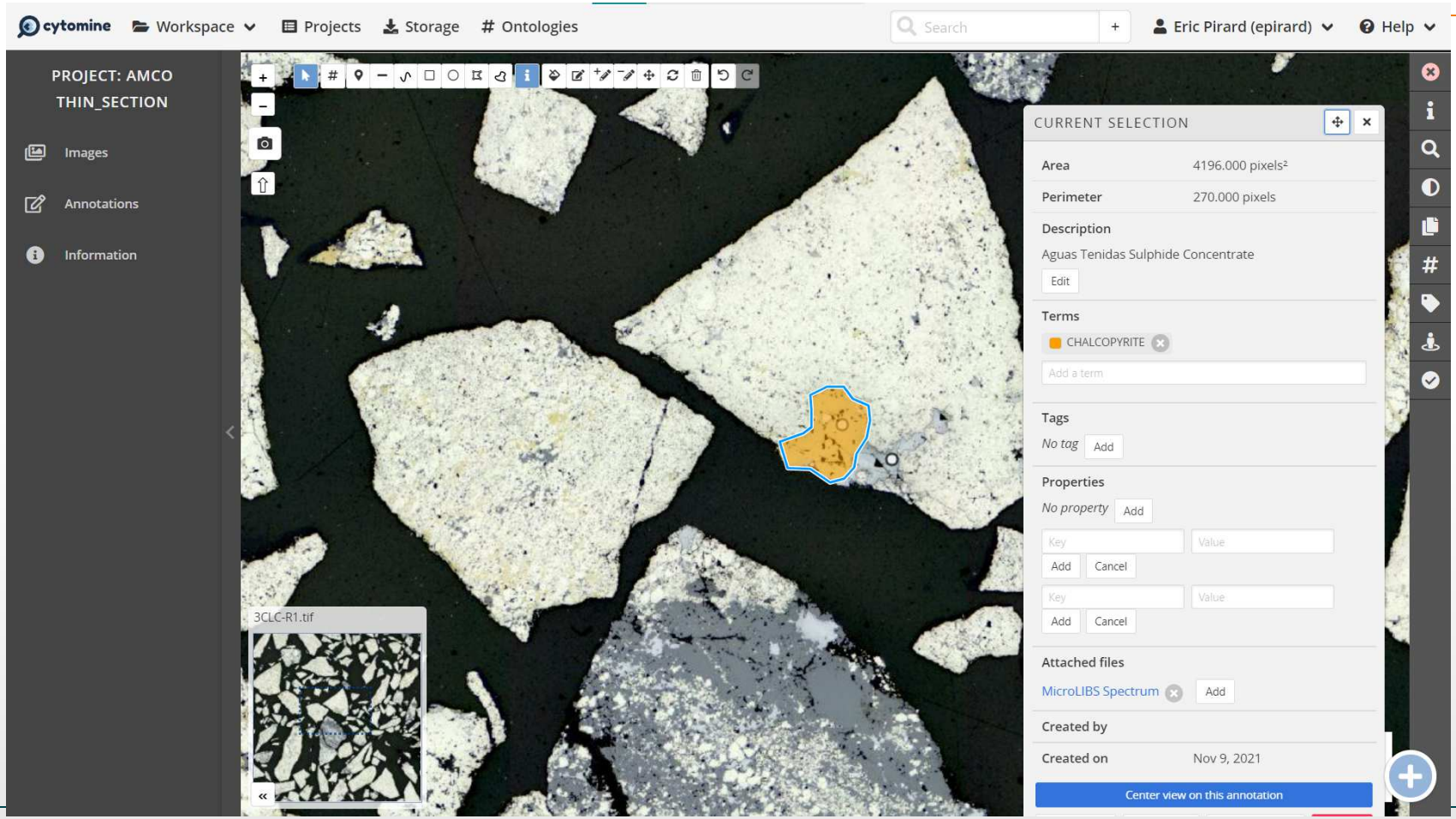
- Open Image DataSet v6
  - Interactive segmentation : Neural Network + Professional Human Annotators

Google AI hopes that having a single dataset with unified annotations for image classification, object detection, visual relationship detection, and instance segmentation will stimulate progress towards genuine scene understanding.

Actionable Intelligence

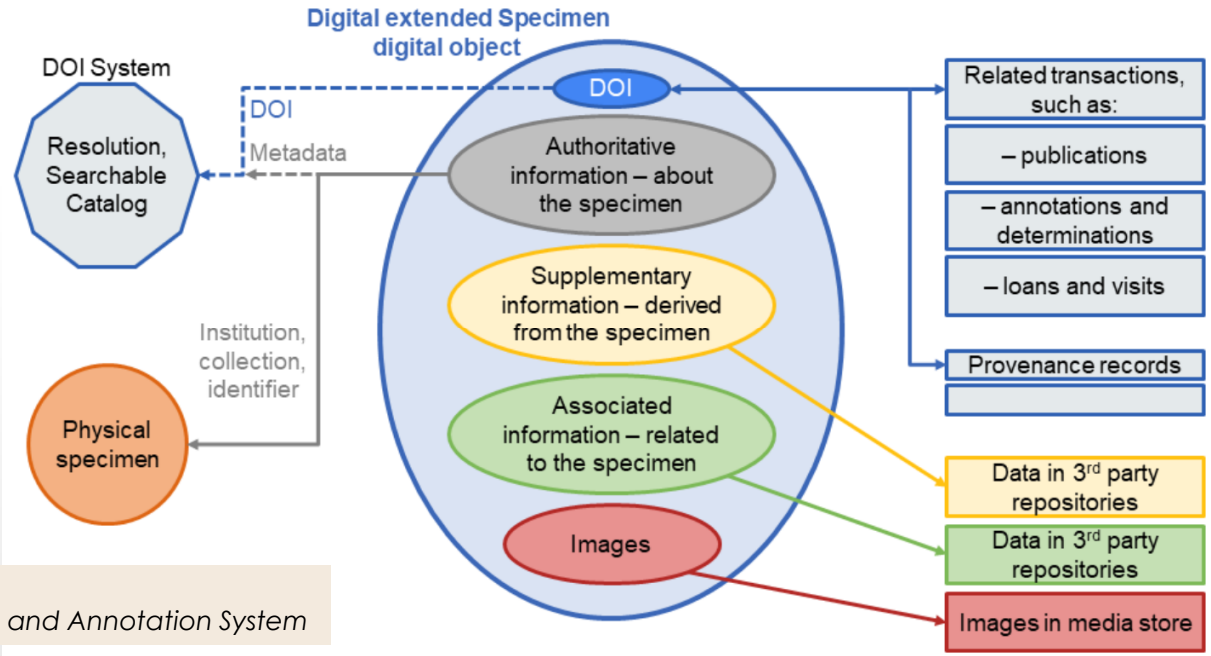


Actionable Intelligence



Sharing Pixels

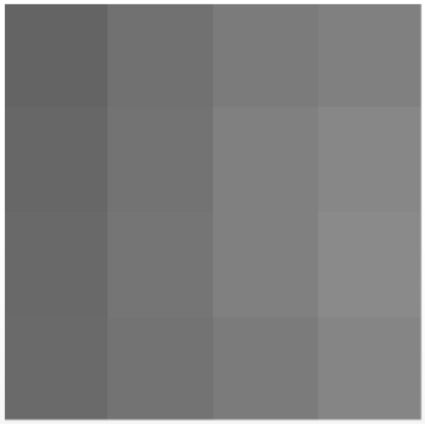
- 2021 – Where do we stand ?
  - Available ~~Crowd-~~ Expert- sharing platforms for annotating images
  - Need to improve
    - Co-option of experts
    - Unified Curation and Annotation System



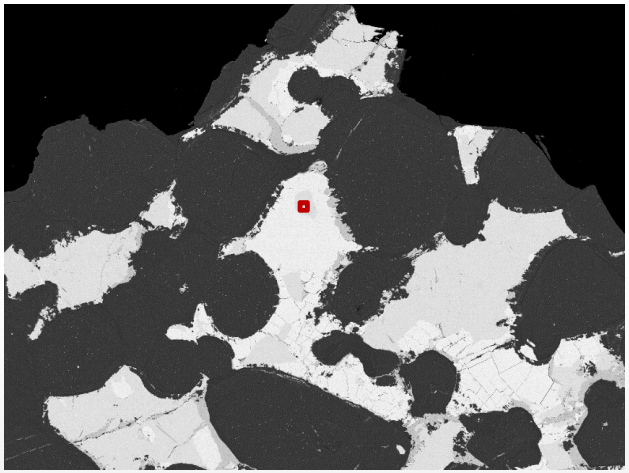
DISSCO-UCAS
Unified Curation and Annotation System

Towards a Digital Twin of the Earth

ThiS Is nOt a PixEL



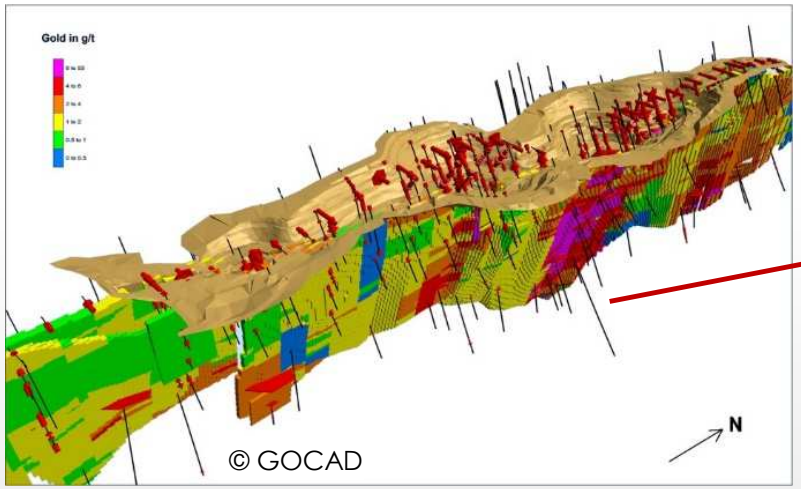
CeCi N'eSt PaS Un PiXeL

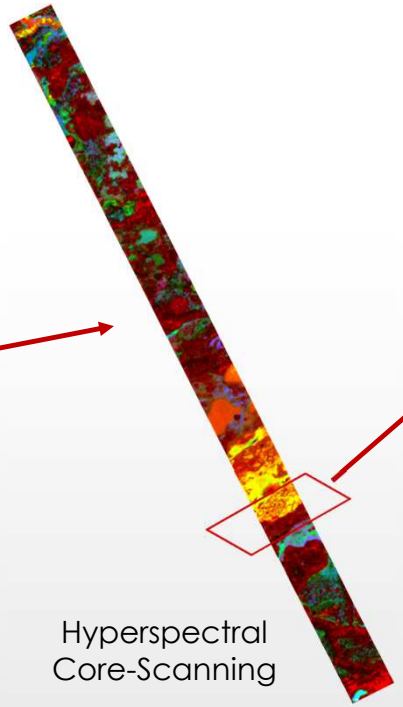


Back Scattered Electrons Image - Raglan (CAN)

From Pixels to Roxels

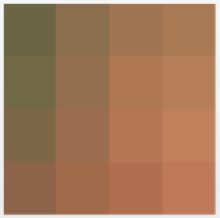
- ROXELS are digital twins of elemental lithological volumes





Hyperspectral
Core-Scanning

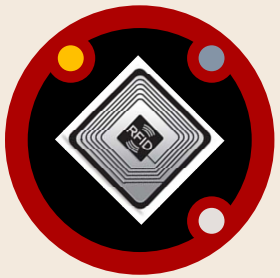
MultiModal
Microscopic Imaging



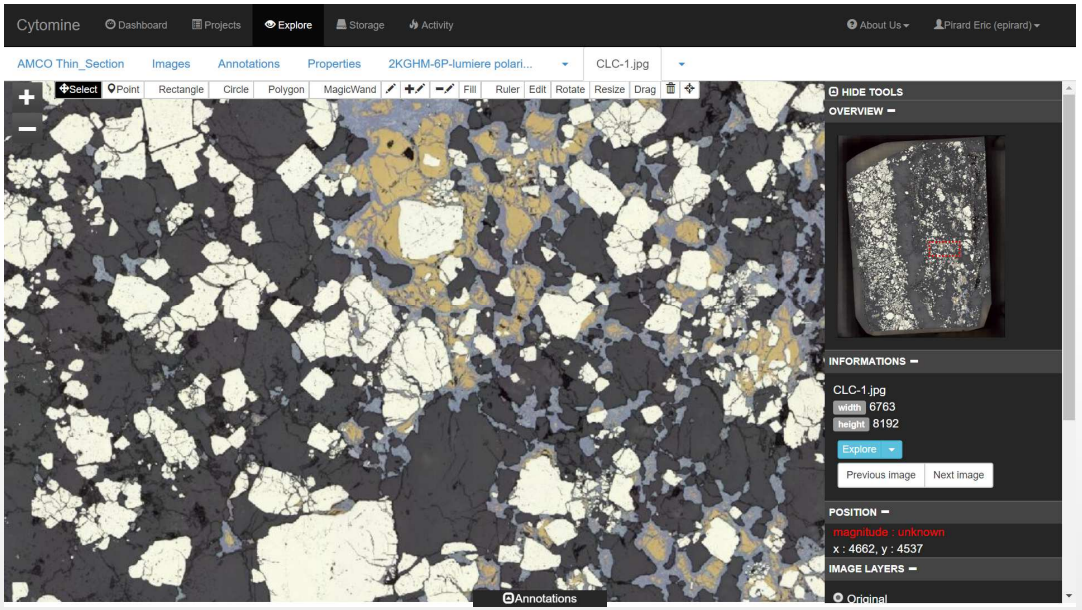
ROXEL

Microscopical Information System

- Deposit(Name type,…)
  - Drill Core (ex. DH1343 Lat/Long/Dip/Azimut/…)
    - Log / Plug (ex. depth/length/…)
      - ✓ Rock_Class (ex. litho type)
        - » *Rock_Compo (ex. modal)*
          - > *Grain (ex. size, shape,…)*
            - + *Roxel_Class*
            - + *Roxel_Compo*
            - + *Roxel_Raw*



Polished Block
RFID / metadata
3 point referencing system



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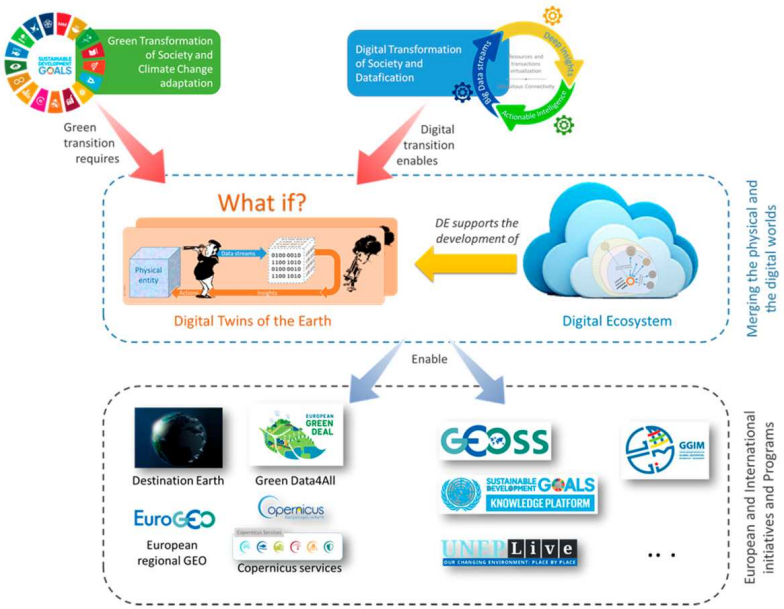
ESA - Digital Twin Earth Challenge

- Conceptually, the goal of **Destination Earth** is to develop a dynamic, interactive, multi-dimensional, and data intensive replica of the Earth (system), which would enable different user groups (public, scientific, private) to interact with vast amounts of natural and socio-economic information. At the heart of Destination Earth is a common infrastructure providing access to data, advanced computing (including high performance computing), software, AI applications, and analytics
  - weather forecasting and climate change,
  - food and water security
  - global ocean circulation
  - biogeochemistry of the oceans
  - Waste management, smart cities and more yet to be defined…

Nothing about the Earth Crust and its georesources!



Nativi, S.; Mazzetti, P.; Craglia, M. Digital Ecosystems for Developing Digital Twins of the Earth: The Destination Earth Case. Remote Sens. 2021, 13, 2119. https://doi.org/10.3390/rs13112119

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Conclusion

Conclusions and way forward

- Where do we stand in 2021?
  - Mature Imaging Technologies
  - Mature Web-based Image Exploration Platforms
  - Potential for a large image database of minerals and rocks
  - Powerful Artificial Intelligence Accessible

- RockePedia
  - Worldwide initiative to cure scientific rock images
  - Development of an expert community
  - Definition of a Unified Annotation Language (cf. GeoSciML, EarthResourcesML,…)
  - Training set for automated Rock Identification (minerals and relationships)
  - Exceptional resource for online education