

Towards best practices for using satellite Earth Observation in mining and extractives

EU-Latin America Mining & Exploration Convention and Trade Show METS 2018
11 April 2018 | Madrid Marriott Auditorium | Madrid, Spain

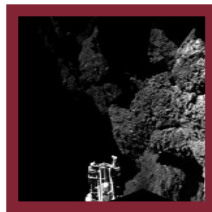
Zoltan Bartalis

**European Space Agency (ESA ESRIN)
Directorate of Earth Observation Programmes
Science, Applications and Climate Department**

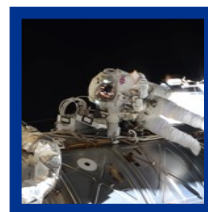
European Space Agency: Activities



ESA is one of the few space agencies in the world to combine responsibility in nearly all areas of space activity.



space science



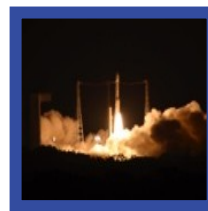
human spaceflight



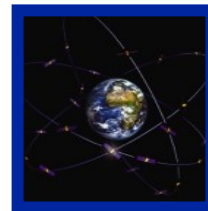
exploration



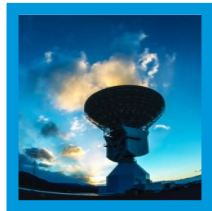
earth observation



launchers



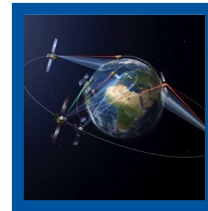
navigation



operations

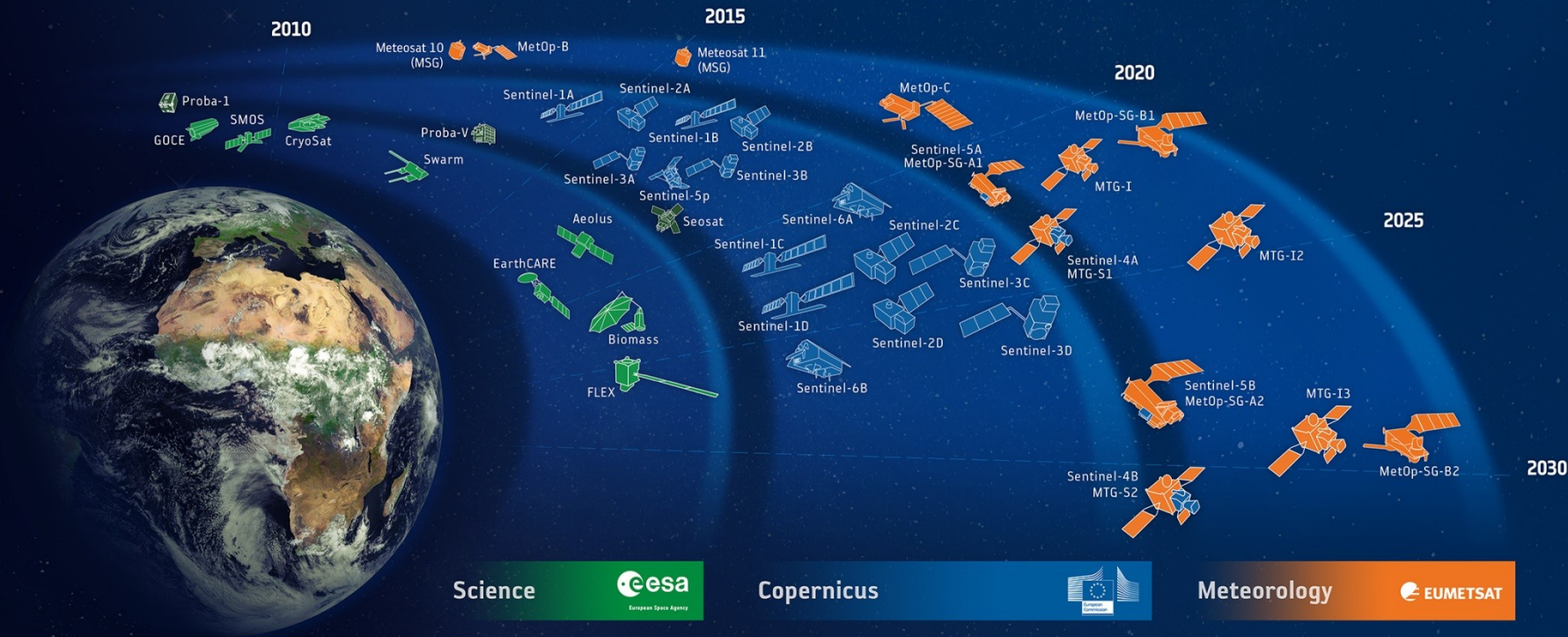


technology



telecommunications

ESA-DEVELOPED EARTH OBSERVATION MISSIONS



The European EO Service Industry

- More than 450 suppliers (small companies), with 7800 highly skilled staff
- More than 350 specialised EO information products and services
- 1247 M€ annual turnover in Europe (services + data)

EARSC

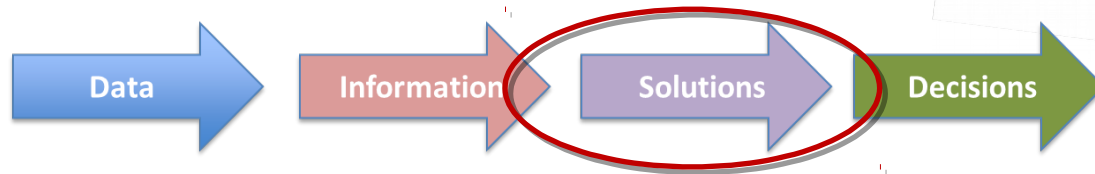
European Association
of Remote Sensing
Companies

A Survey into the State &
Health of the European EO
Services Industry

Prepared by EARSC with the support of ESA

2017

EARSC



European Space Agency

Earth Observation (EO) Capabilities Relevant to Mining and Raw Materials



- Combination of optical (multispectral) and microwave (SAR) data to provide:
 - geological mapping: structural / lineament / lithological maps
 - land cover classification / change
 - surface topography (elevation)
 - precision land motion monitoring
 - feature/object detection
- Supporting wide range of activities in mining and its business processes, e.g.
 - prospection
 - exploration
 - operations and logistics planning
 - closure / reclamation / rehabilitation

Paper G 14

MINERAL EXPLORATION WITH ERTS IMAGERY

Stephen M. Nicolais, Colorado School of Mines

ABSTRACT

N 74 30759

Ten potential target areas for metallic mineral exploration were selected on the basis of a photo-lineament interpretation of the ERTS image 1172-17141 in central Colorado. Of the ten target areas selected, five included the following mineral districts: the Breckenridge district, the Leadville-Climax-Alma area, and the Tomichi, Bonanza and Cripple Creek districts. An evaluation of bias indicated that prior geologic knowledge of the region had little, if any, effect on target selection. In addition, a contoured plot of the frequency of photo-lineament intersections was made to determine what relationships exist between the photo-lineaments and mineral districts. Comparison of this plot with a plot of the mineral districts indicates that areas with a high frequency of intersections commonly coincide with known mineral districts. The results of this experiment suggest that photo-lineaments are fractures or fracture-controlled features, and their distribution may be a guide to metallic mineral deposits in Colorado, and probably other areas as well.

S. M. Nicolais (1974): "Mineral Exploration with ERTS Imagery"

Earth Observation (EO) Capabilities Relevant to Mining and Raw Materials



- Copernicus Sentinel-1 and Sentinel-2: the workhorses (global, frequent revisit, free access)
- National/commercial missions for local "hotspot" monitoring at higher resolutions (e.g. TerraSAR-X, COSMO-SkyMed, Pléiades, Deimos-2, etc.)
- Exploratory hyperspectral missions (e.g. EO-1 Hyperion, HyperScout, EnMap) for enhanced surface mapping (i.e. minerals, rock types, etc.)

Paper G 14

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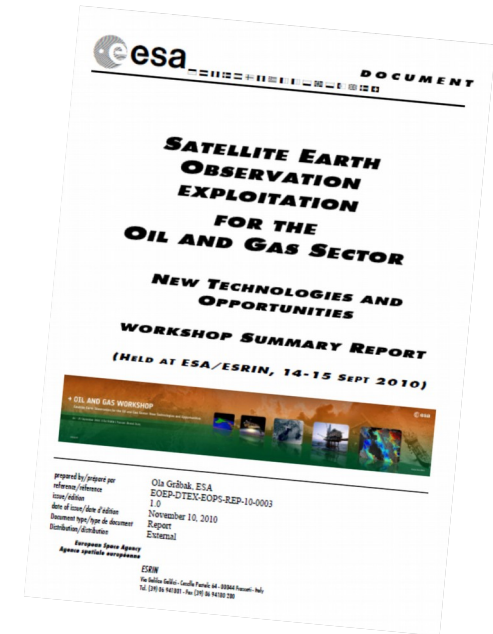
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Example of the Expansion of EO Information Services Across the Oil & Gas Industry



- Since 2010 ESA actively cooperating with the Oil & Gas sector
- OGEO: industry-led working group for EO, now formalised within IOGP
- Together with EARSC:
 - 230 challenges O&G companies face → 92 EO products identified (EO4OG Portal)
 - Portal also set up for information exchange: www.ogeo-portal.eu



New Activity in 2018 for EO for Best Practices in Mining



- New 18-month activity starting in 2018 to work with the mining sector to:
 - establish the sector's geoinformation needs
 - for the entire mining cycle
 - for public entities in the regulatory, legislative and supervising process
 - devise best practice guidelines for the use of Earth Observation based products and services.
- Best practices will:
 - Increase the awareness of EO-based solutions
 - Develop common product specifications and quality levels
 - Provide up-to-date information on EO capabilities in a consistent and standardised format
 - Improve the procurement of EO-based solutions
 - Testing the use of virtual platforms as a way to showcase and provide EO-based solutions
- Collaboration with:
 - European Innovation Partnership (EIP) on Raw Materials
 - International study groups of the lead and zinc, copper, and nickel industries
 - etc.

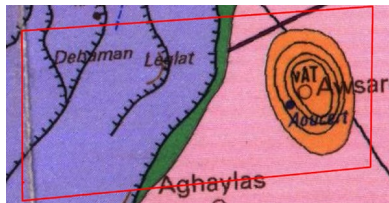


Supporting Large-Scale Geological Mapping: African Mineral Geoscience Initiative (AMGI)

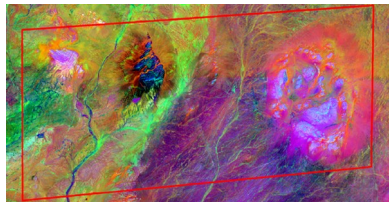


Test case: Western Sahara

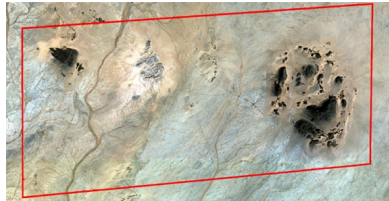
Existing
geological
map,
1:1 million,
1985



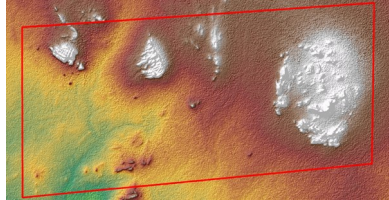
Principal
component
analysis
based on
Sentinel-2



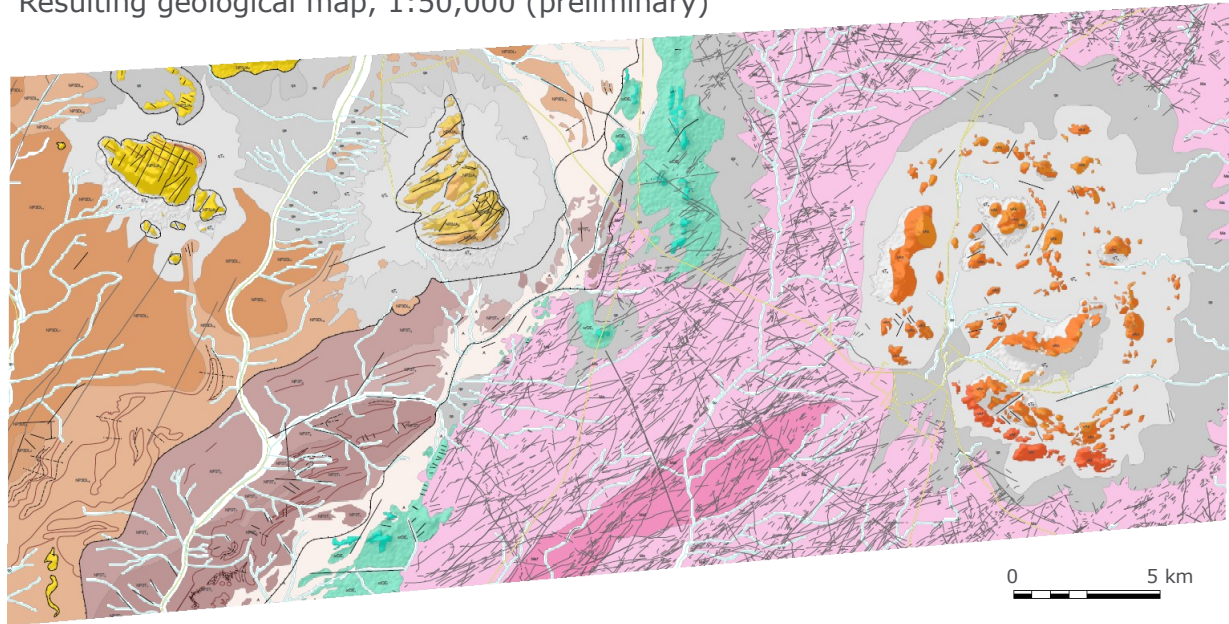
Sentinel-2
natural colour
image



SRTM
elevation



Resulting geological map, 1:50,000 (preliminary)



GAFAG



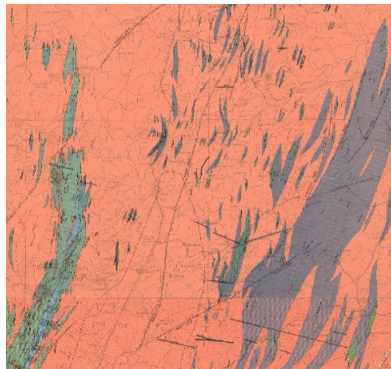
European Space Agency

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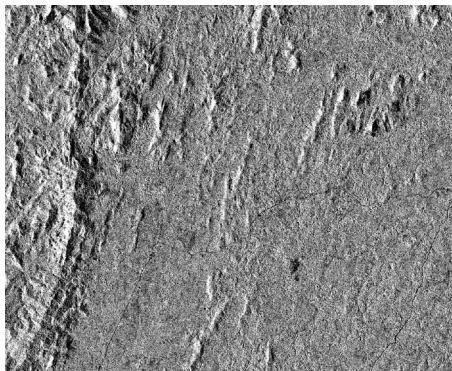


Test case: Sierra Leone

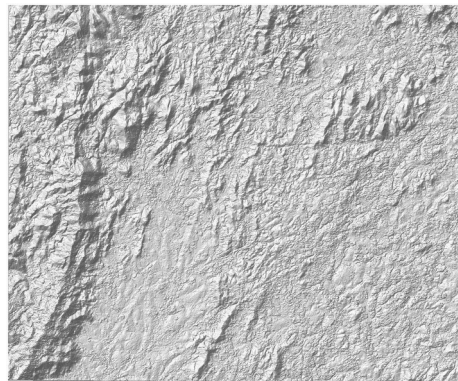
Existing geological map 1:50 000



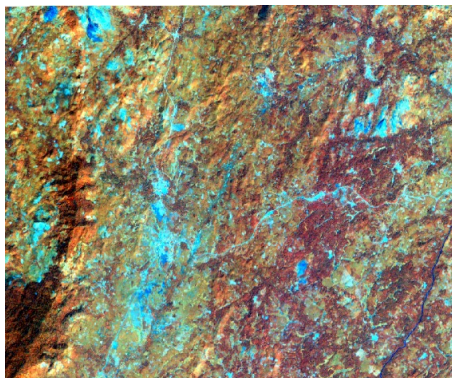
Sentinel-1 backscatter



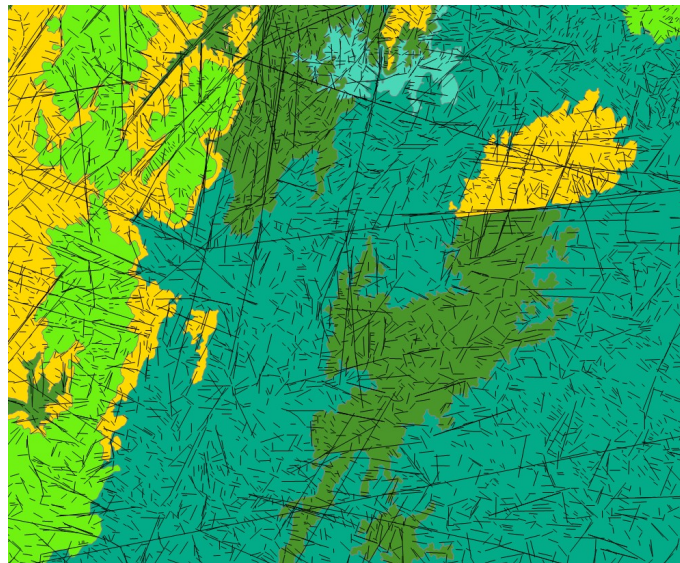
WorldDEM elevation



Sentinel-2 RGB bands 7-5-4



Resulting geological map, 1:25,000



GAFAG

WORLD BANK GROUP



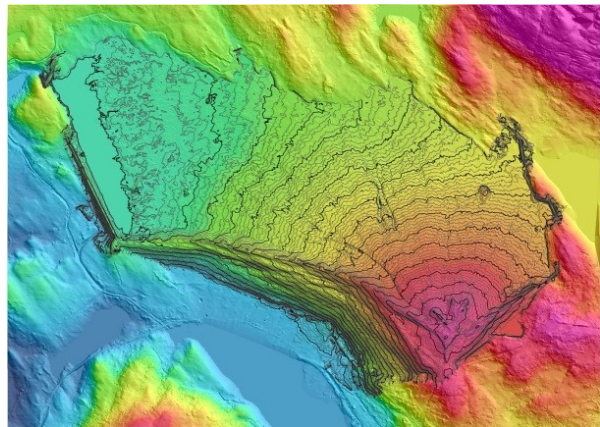
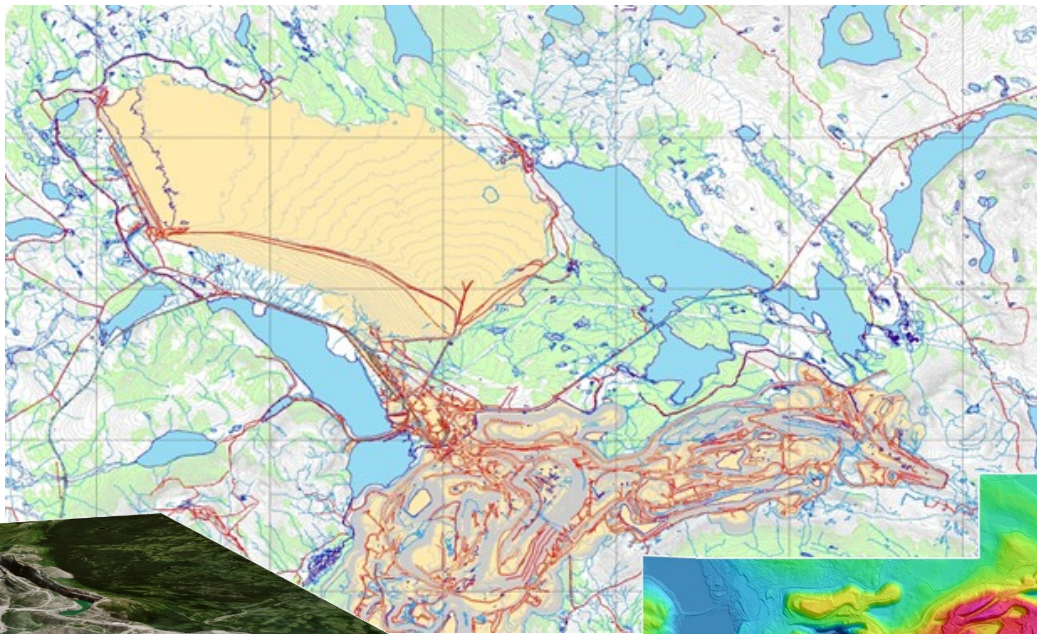
European Space Agency

Supporting Operations: Land Surface Type Mapping

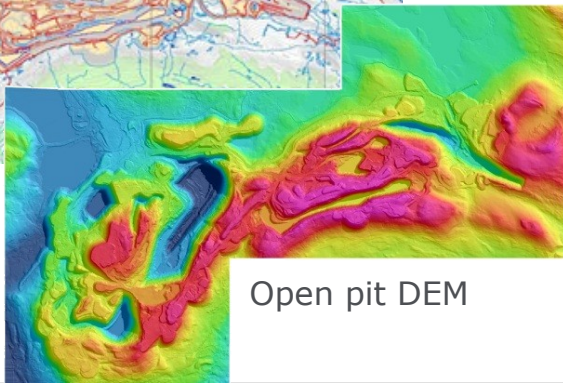
- Ferric concentration (Fe^{3+}), Chile, from WorldView-3
- When inside the mining area, this can indicate potential leakage or contamination



Supporting Operations: Precision Topography



Tailings DEM

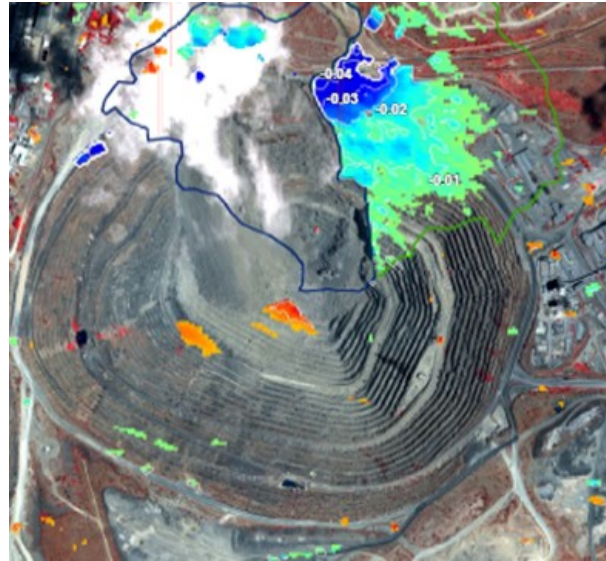


Open pit DEM

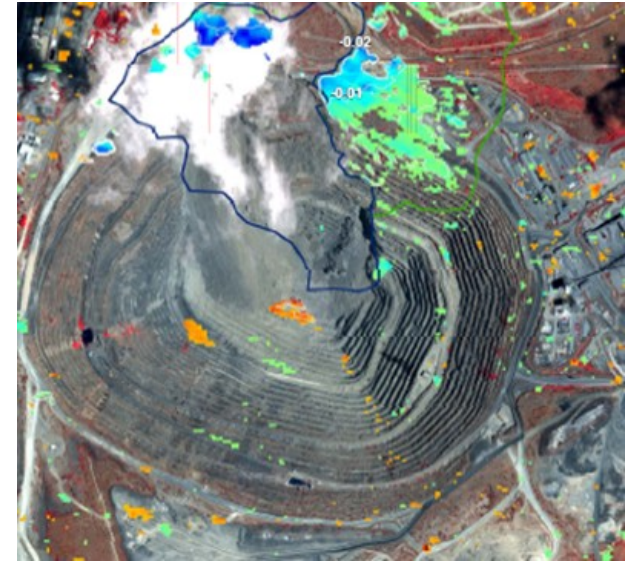
Supporting Operations: Precision Land Motion Mapping



- Palabora open pit copper mine, South Africa
 - Up to 4 cm subsidence in a 24 day period



2004 Jul 22-Aug 16



2004 Aug 16-Sep 8

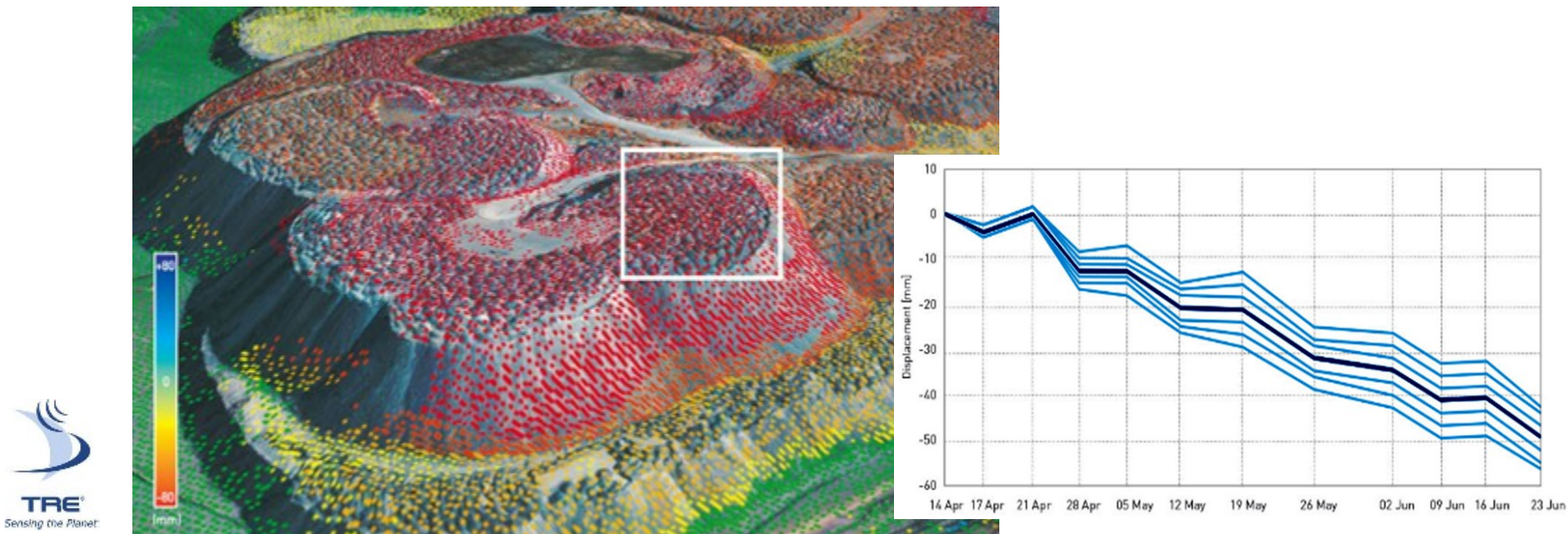
RioTinto

amec

-0.04 0.04 m

Waste pile monitoring via Persistent Scatterer Interferometry (PSI)

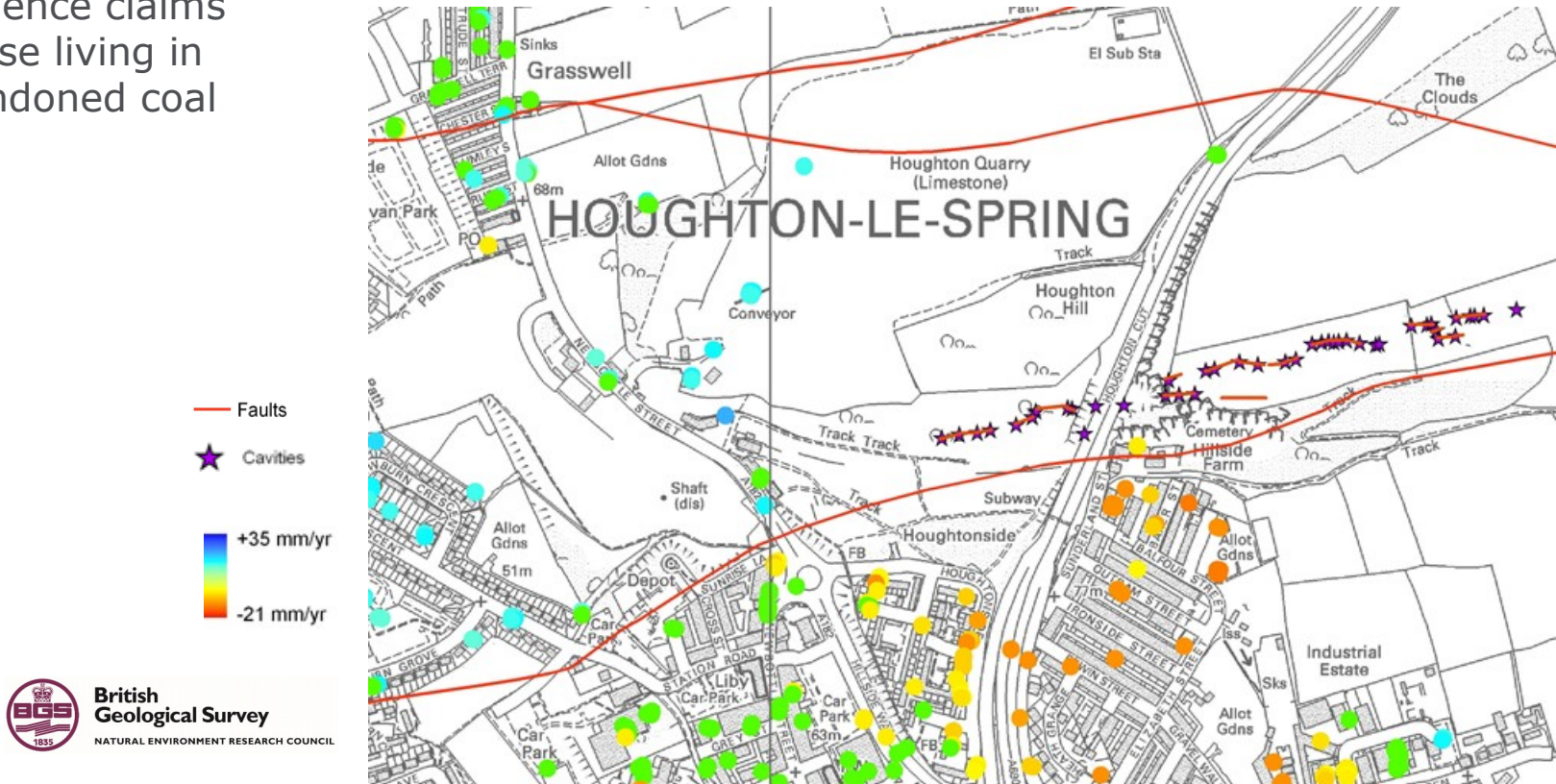
- The barren rock and gravel cover results in high densities of PSI points (>10000 points/km²)
- More complete coverage than any other technique for displacement measurements with millimetre-precision



Supporting Post-Closure and Rehabilitation: Precision Land Motion Monitoring



Issue: subsidence claims raised by those living in areas of abandoned coal mining



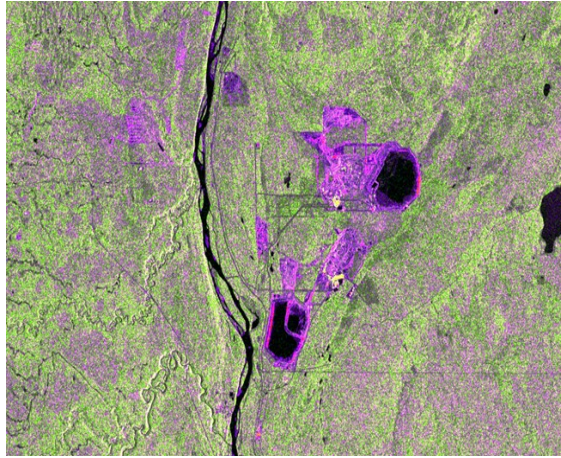
Supporting Sustainable Development: Land Cover Change Mapping



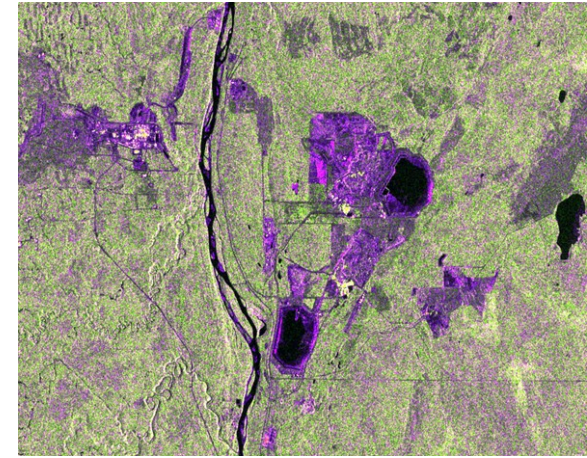
Unbiased, timed satellite images help building stakeholder trust because they clearly illustrate the activities taking place in our oil sands mine leases; they present clear, accessible visuals to stakeholders such as First Nations people who live in the area; they provide objective information on development and eventual reclamation of our oil sands leases and help us to expand our annual reporting on environmental performance, including future reclamation areas. Using 2006 as a baseline, we intend to repeat monitoring by satellite on a yearly basis, to record our mine development and our progressive reclamation of involved areas.

Ashley Nixon

SD Advisor, Shell Canada Ltd



2005



2006



European Space Agency

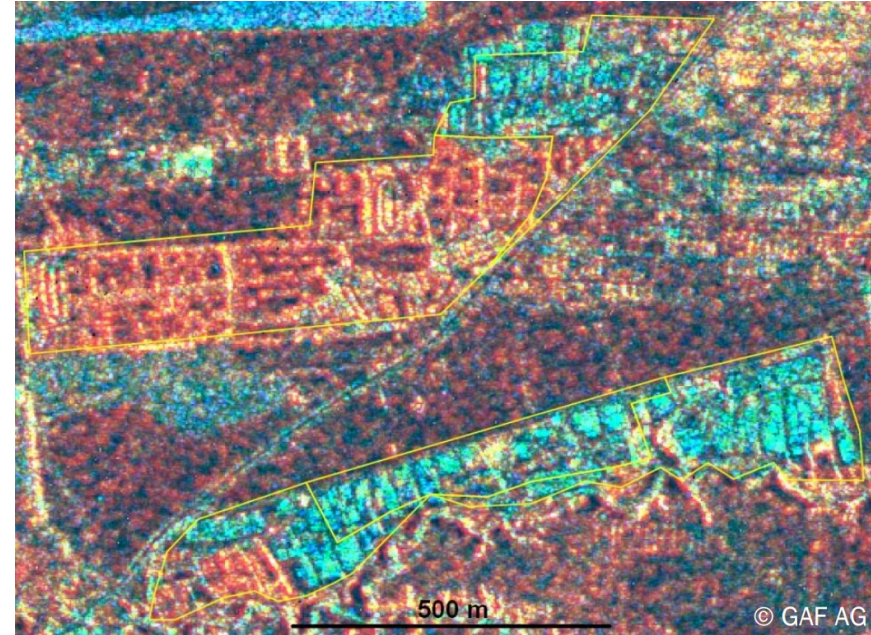
Activity Monitoring with Multitemporal Coherence

- Clay brick production

Kabul, Afghanistan



Cartosat-1 IRS-P5,
24 May 2010

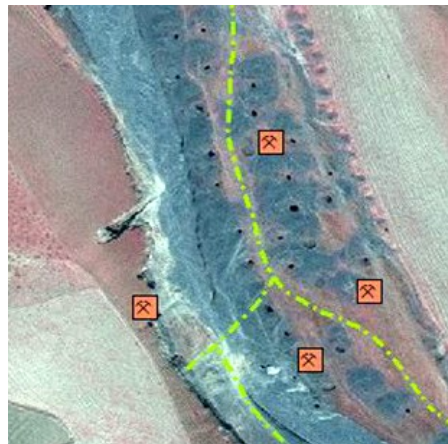


Changes in coherence between
4 and 20 June 2012:
Blue = low coherence = high activity

Supporting Detection of Illegal Mining: Feature Identification

- Three classes of users:
 - **International organisations** assessing threat from international organised crime
 - **National governments** monitoring natural resource extraction
 - **Mining companies** monitoring their own concessions
- Very high-resolution optical and radar data to detect vehicles, irregular excavation, changes in tailings pond extent, etc.
- Excellent monitoring tool for illegal and informal ASM activities to help legalise or manage the sector

Irregular mining:
gold (left), ruby (right)



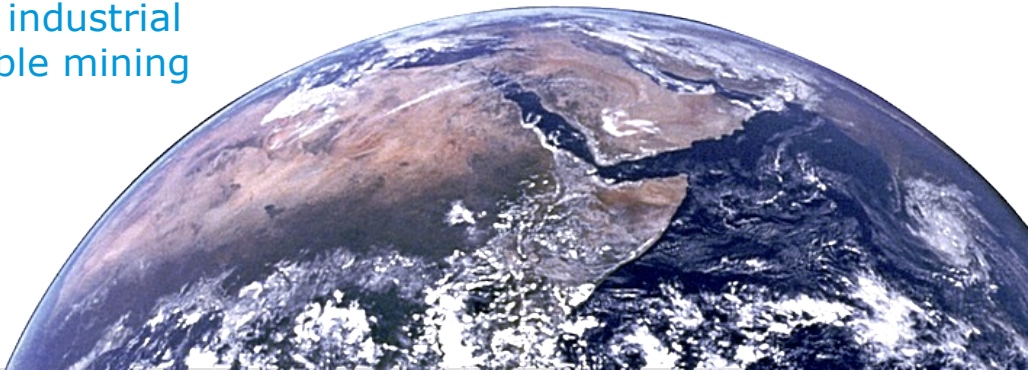
Detection of
vehicles/drilling
equipment
operating
outside license
area



Take-Home Messages




- Earth Observation (EO) can deliver **key environmental information** that supports many aspects of operations in the mining/extractives/raw materials industry.
- EO brings benefits through being **globally consistent/coherent** (both spatially and temporally), providing access to remote regions, non-intrusive source of information.
- Europe has **world-leading capabilities in EO** (both EU, ESA and national EO missions) and a highly skilled and experienced EO information services sector. Developments are complete, ready for operational use. **Copernicus is bringing a major step forward** in progress towards operational environmental information services.
- ESA about to start **new activity** on **EO for industrial best practices for sustainable and responsible mining**
 - **Partners welcome!**



Thank You!

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<http://www.esa.int/eo>

 **@bartalzo**

@ESA 

@EO_OPEN_SCIENCE 