SAFARI

UNIVERSITY OF ABERDEEN

Reservoir Analogues in the 21st Century:

Lasers Scanners, UAVs and Virtual Outcrops

John Howell

Finding Petroleum: Transforming subsurface interpretation Aberdeen March 17th 2015

Outline

Why use analogues at all?

How we used to do it

How we do it now

- Collecting analogue data
- Disseminating data

The future …

Outline

Why use analogues at all?

How we used to do it

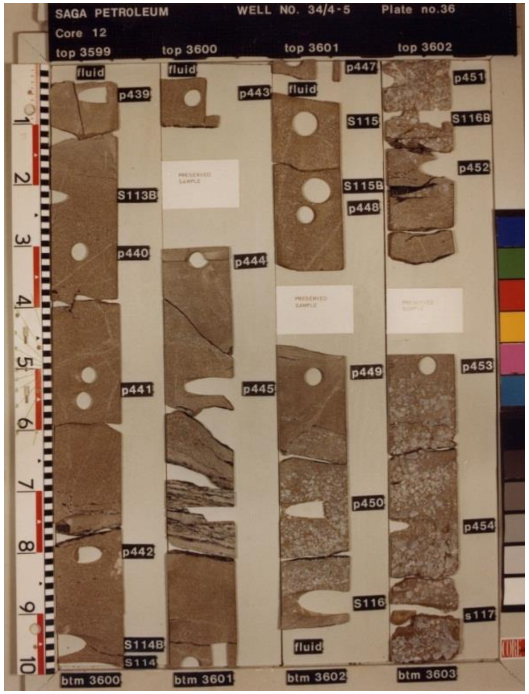
How we do it now

- Collecting analogue data
- Disseminating data

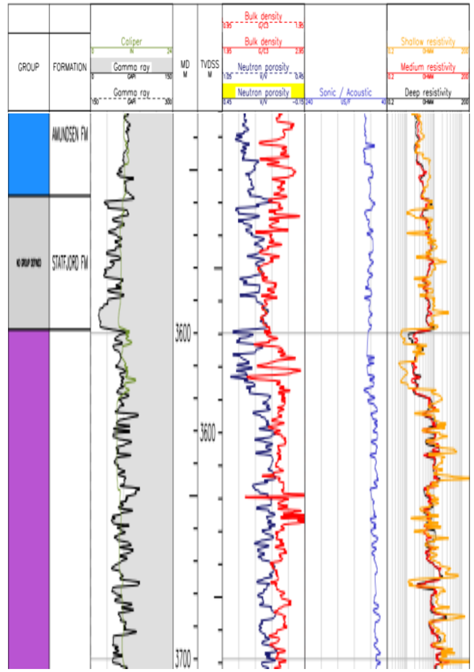
The future …

The problem with subsurface data...

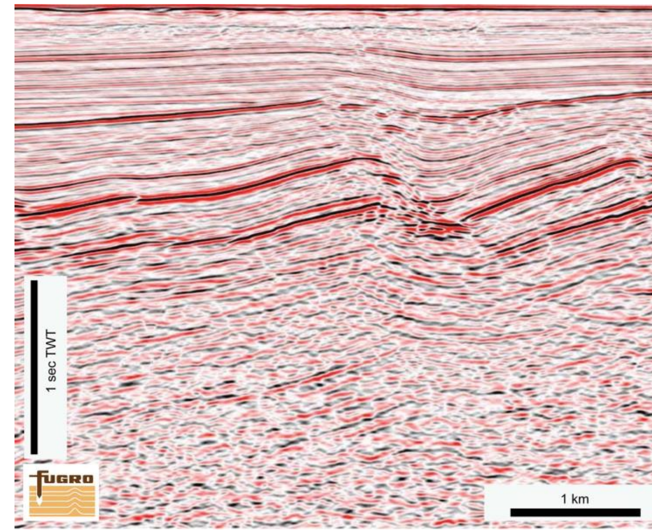
UNIVERSITY OF ABERDEEN



Statfjord core (NPD factpages)



Statfjord well log (NPD factpages)



Seismic line from the inner Moray Firth (VSA)

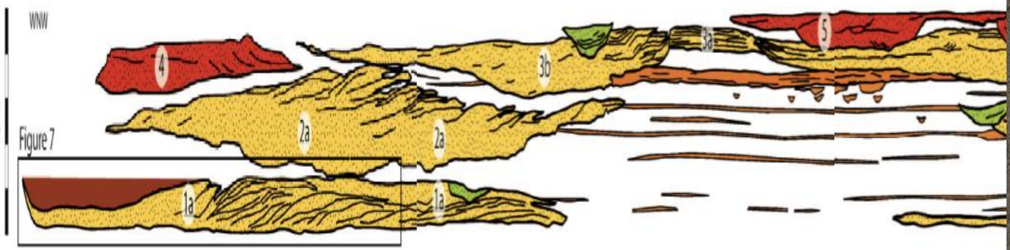
Data coverage

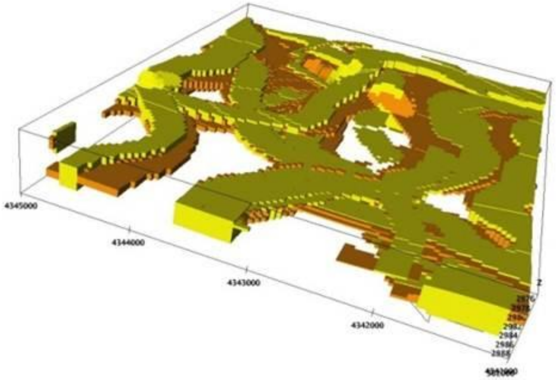
Resolution

Samples 0.000001% of field

Samples 100% of field

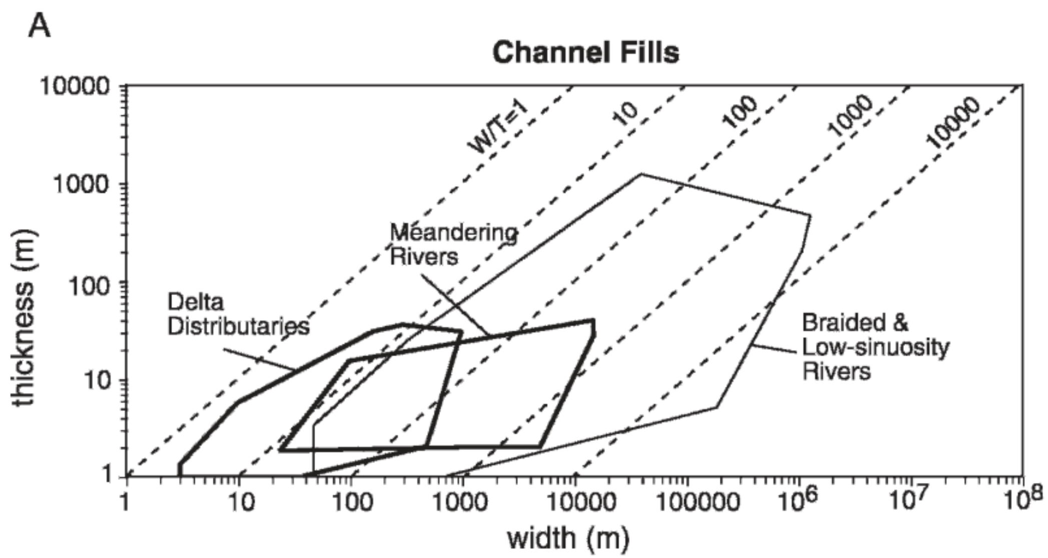
The Solution - Analogues





Uncertainties and challenges

- Collecting data that is accurate and fit for purpose
- Organising the data
- Finding the correct analogue
- Storing and accessing the data
- Having sufficient data
- Having useful data



(Gibling 2006)

Outline

Why use analogues at all?

How we used to do it

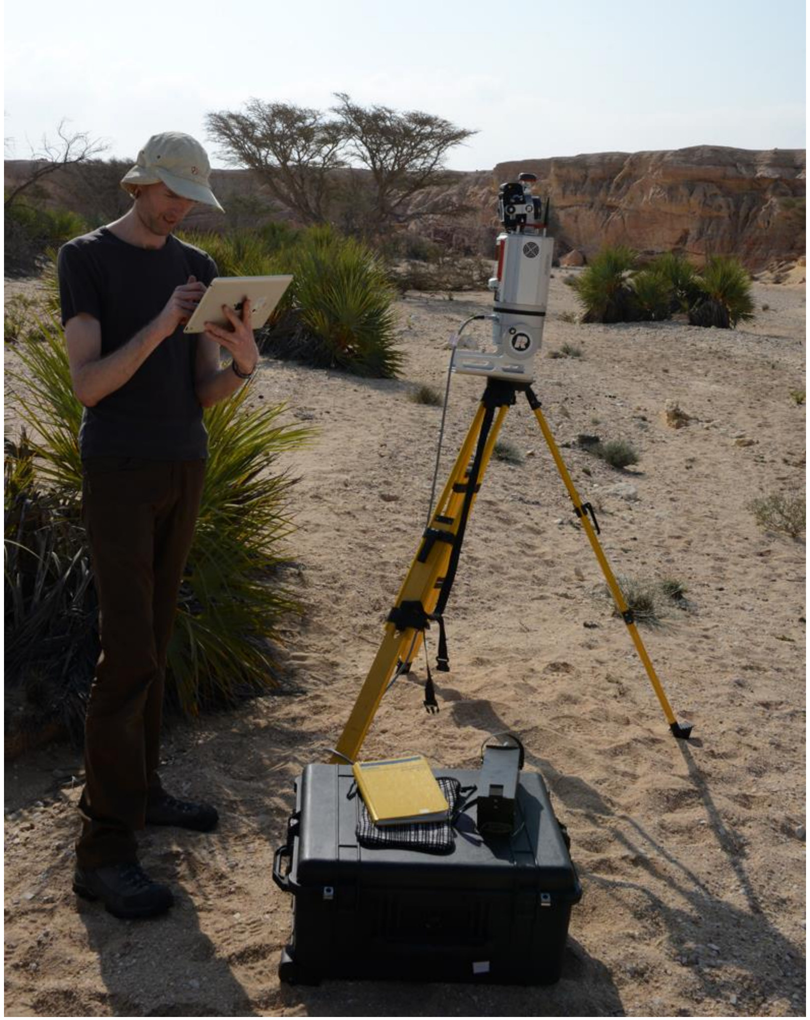
How we do it now

- Collecting analogue data
- Disseminating data

The future …

Photo montages and big cliffs

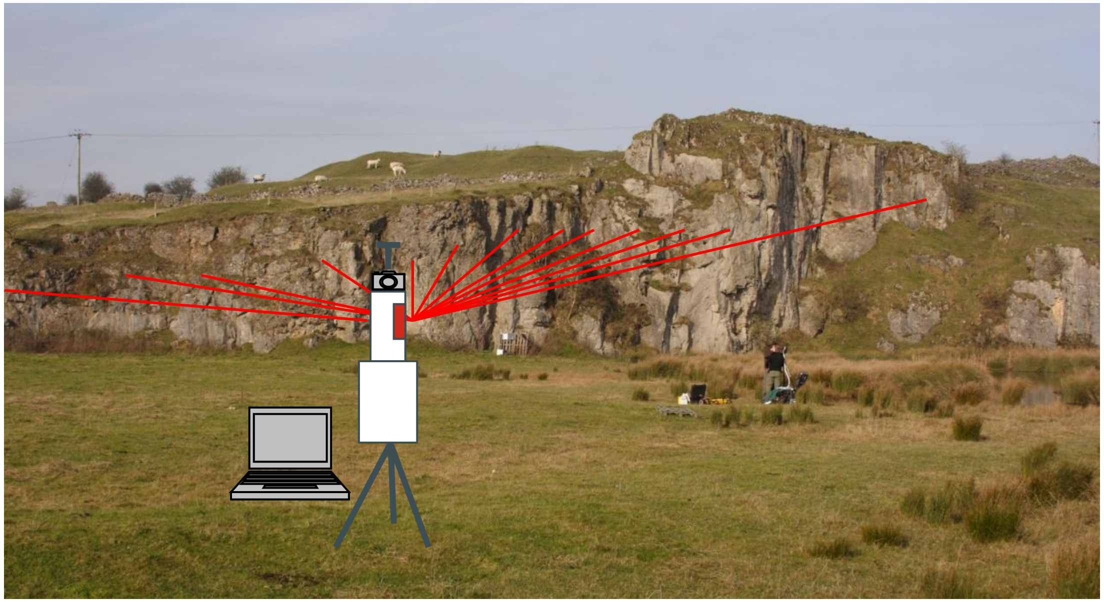
How we do it now (2015)



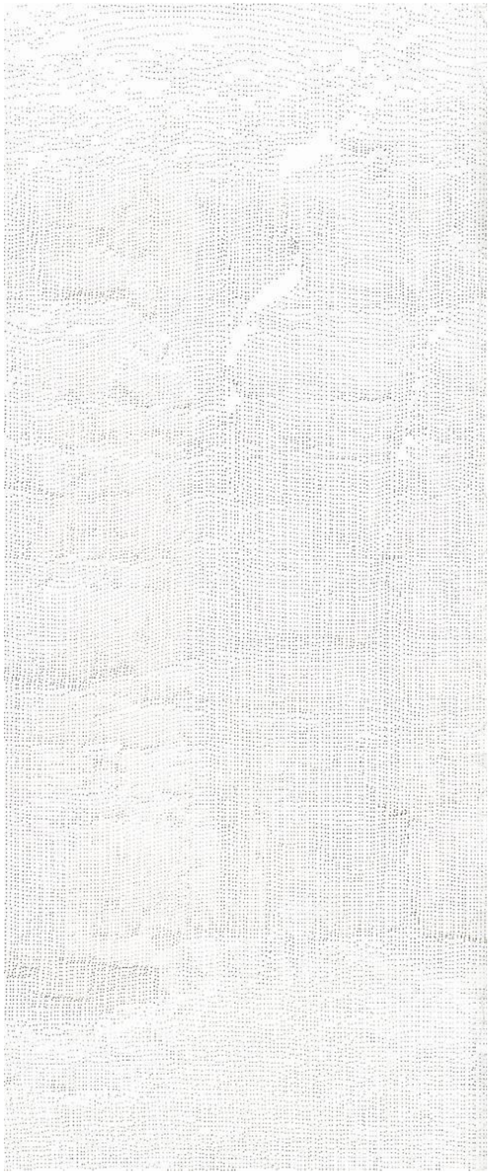
- Riegl 1000 Lidar
- Internal memory
- Internal GPS
- 100,000 points per second
- Typical scan time < 5 mins
- 30 Scans in a day
- Run from ipad

Laser Scanning principals

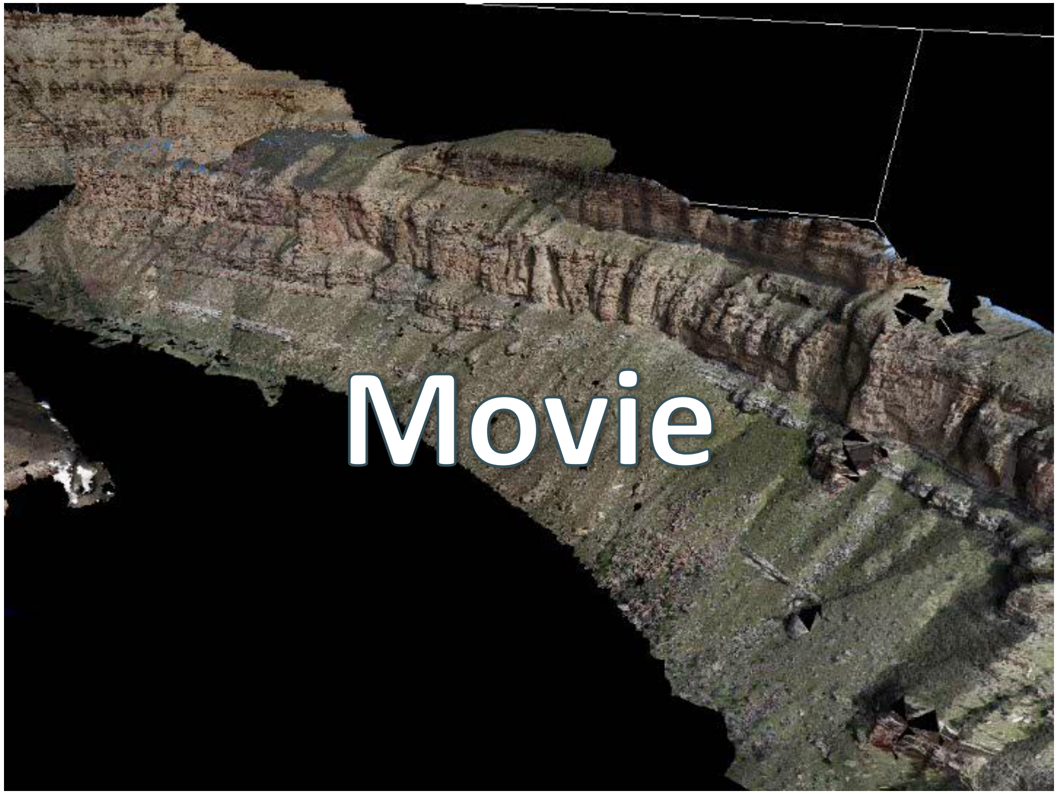
- **Rapid means of acquiring 3D point data**
- **Based on time-of-flight of laser**
- **Measures four components:**
  - Hz angle, v angle, distance
  - strength of laser return (intensity)
- **Converts to x, y, z coordinates and produces a *point cloud***
- **80° × 360° field of view**
- **up to 100,000 points/sec**
- **max range 1200 m**
- **quoted point accuracy of 5 mm**



Processing workflow



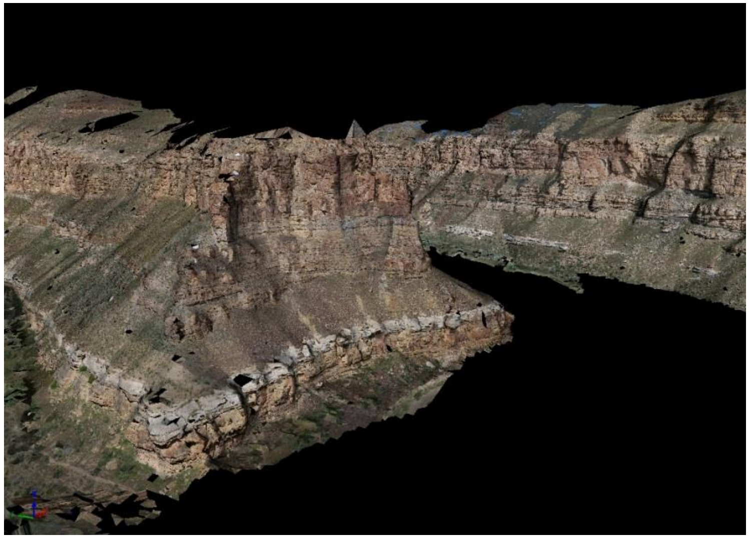
Data collection to Virtual Outcrops

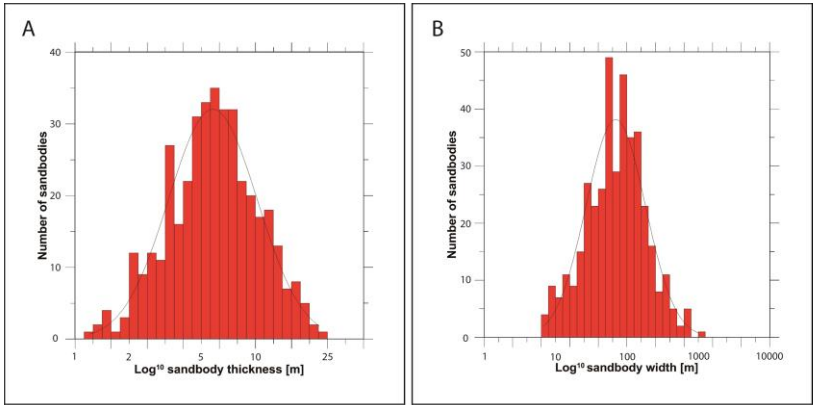


- The product of all this work is a Virtual Outcrop
- Having a 3D model that can be spun around is very impressive

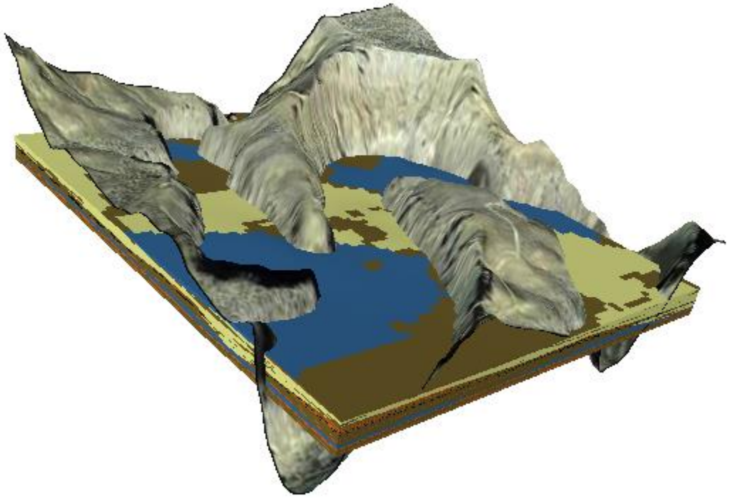
  ... for about 10 minutes
- There are 2 key aspects of virtual outcrops
  1. The ability to collect field data faster and more efficiently than using conventional techniques
  2. The ability to collect data that is not measurable in the field (e.g. structural dips of <0.5°)

What do we do with Virtual Outcrops?

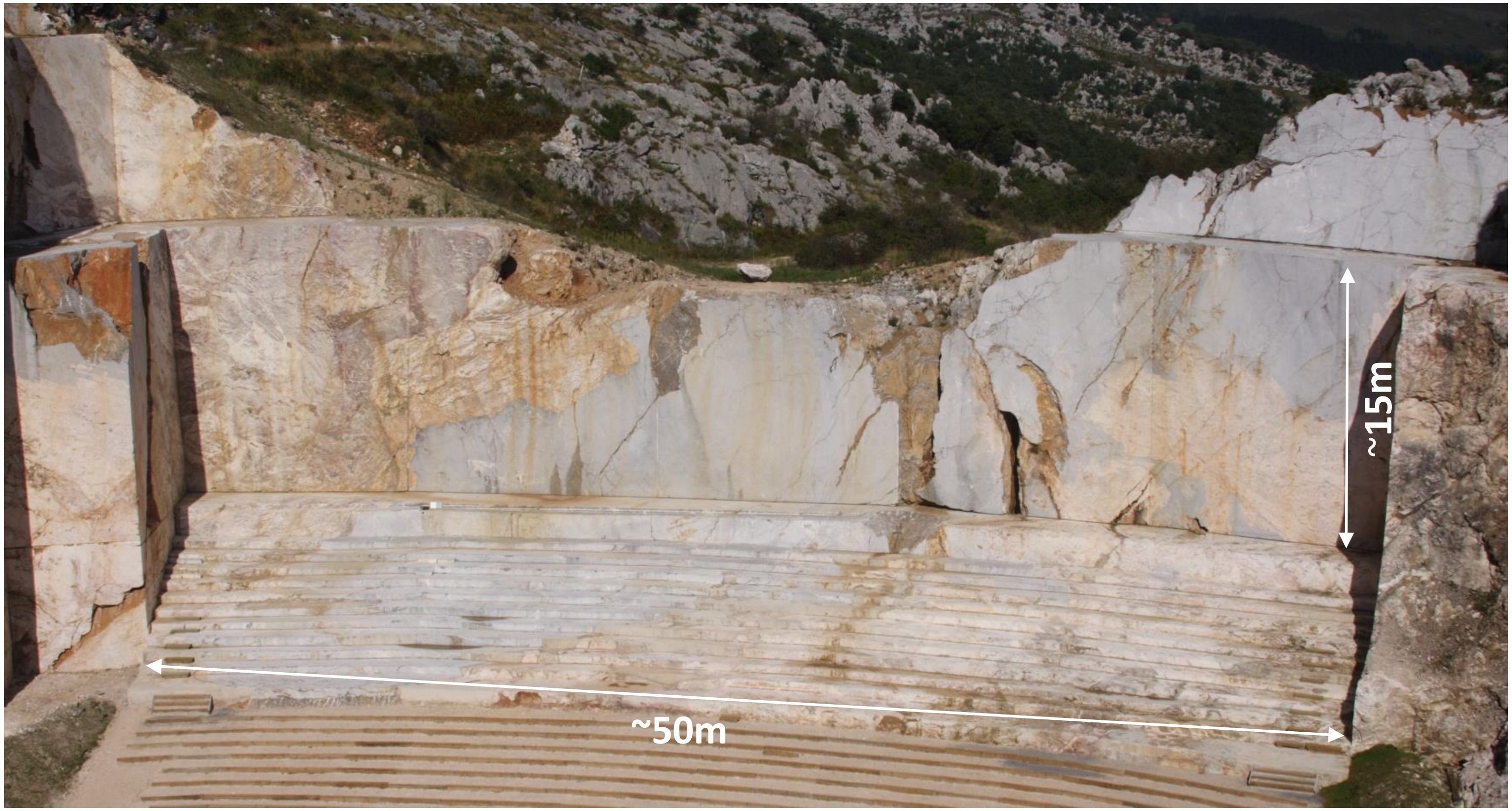




- **Collect geometric data on the dimmensions of architectural elements**
- **Model outcrop analogs to answer specific subsurface questions**



Can we do better?

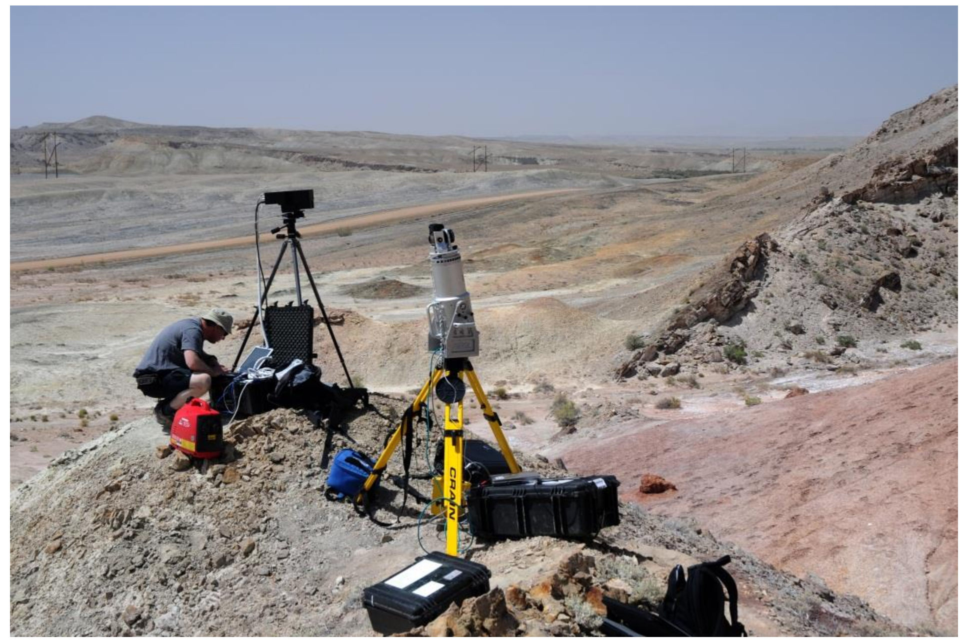


All that interpreting lithology is time consuming and not very quantitative...

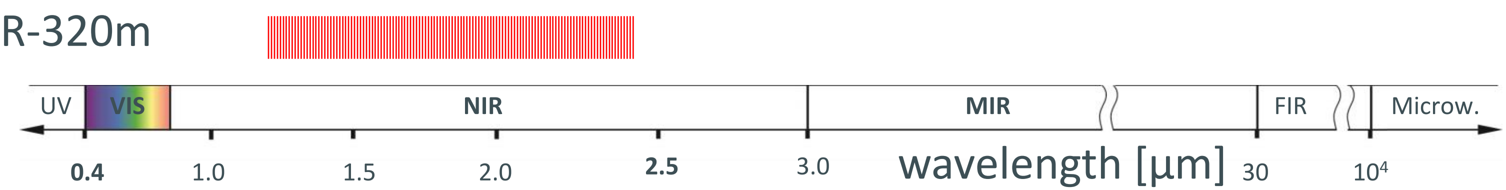
Hypersectral Equipment

- Spectral range: 1.3 - 2.5 µm
- Spectral sampling: 5 nm
- Number of bands: 240
- Spatial pixels: 320
- Field of View (FOV): 14°

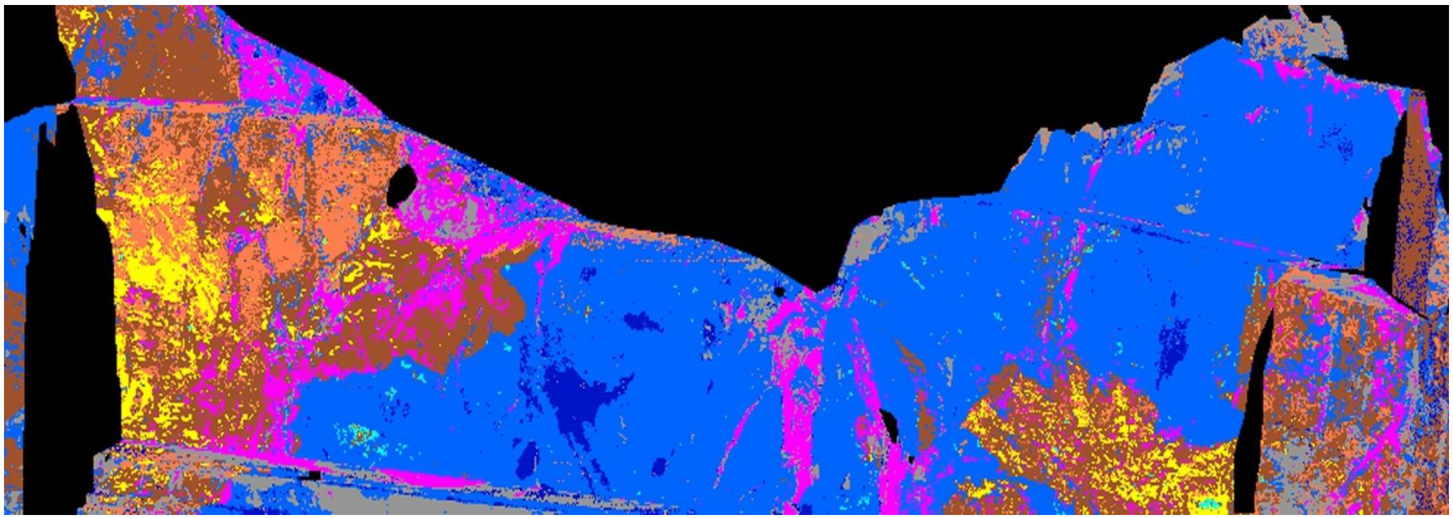
Sensor with rotation stage



HySpex[R] SWIR-320m



Case Study – Renero Quarry

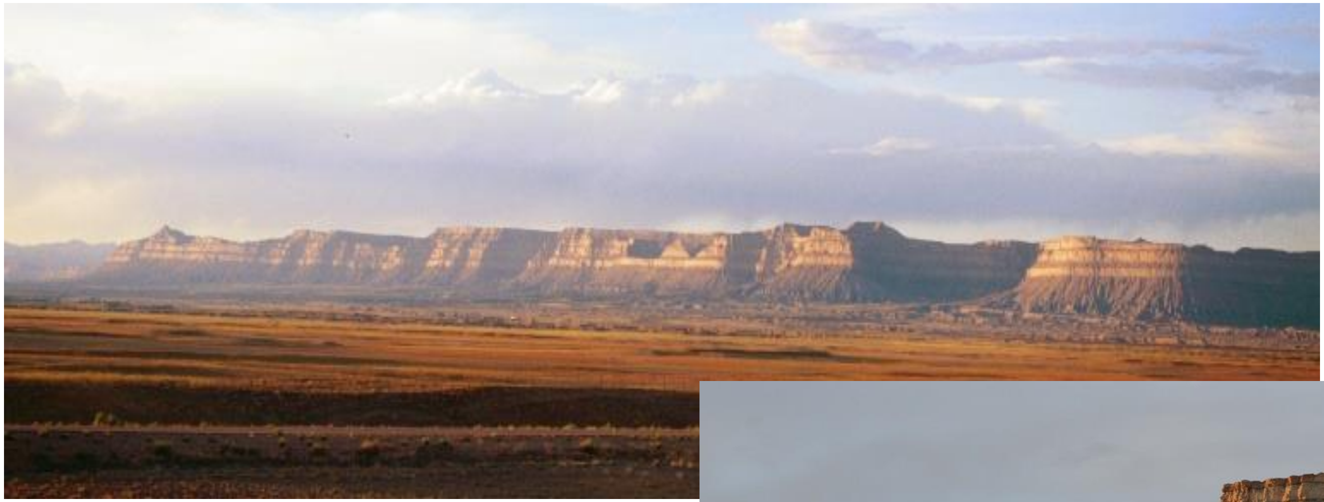


- host limestone, 438.9 m^2
- pure calcite, 3.4 m^2
- organic rich limestone, 23.4 m^2
- coarse crystalline dolomite, 37.3 m^2
- zebra dolomite, 75.8 m^2
- dolomite (not differentiated), 195.4 m^2
- recent karst, 83.9 m^2
- not classified, 54.3 m^2
- masked pixels

- Aptian limestone succession (carbonate platform slope deposits) affected by hydrothermal dolomitisation

-Palaeo-karstification episodes associated with the cyclic deposition of the carbonates related to the opening Bay of Biscay

Range and orientation limitations

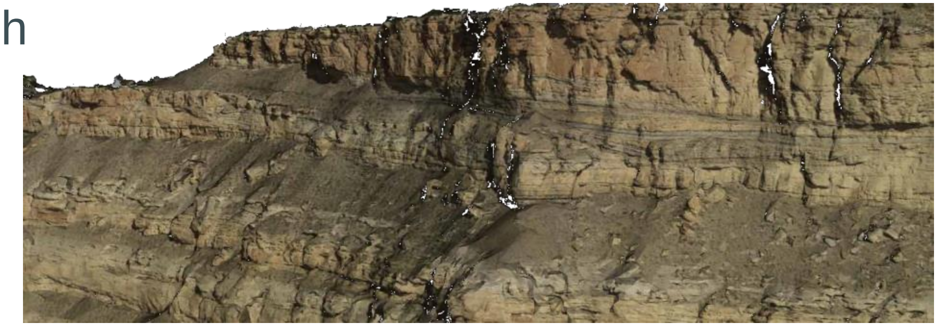


Heli-lidar (2008 to present)

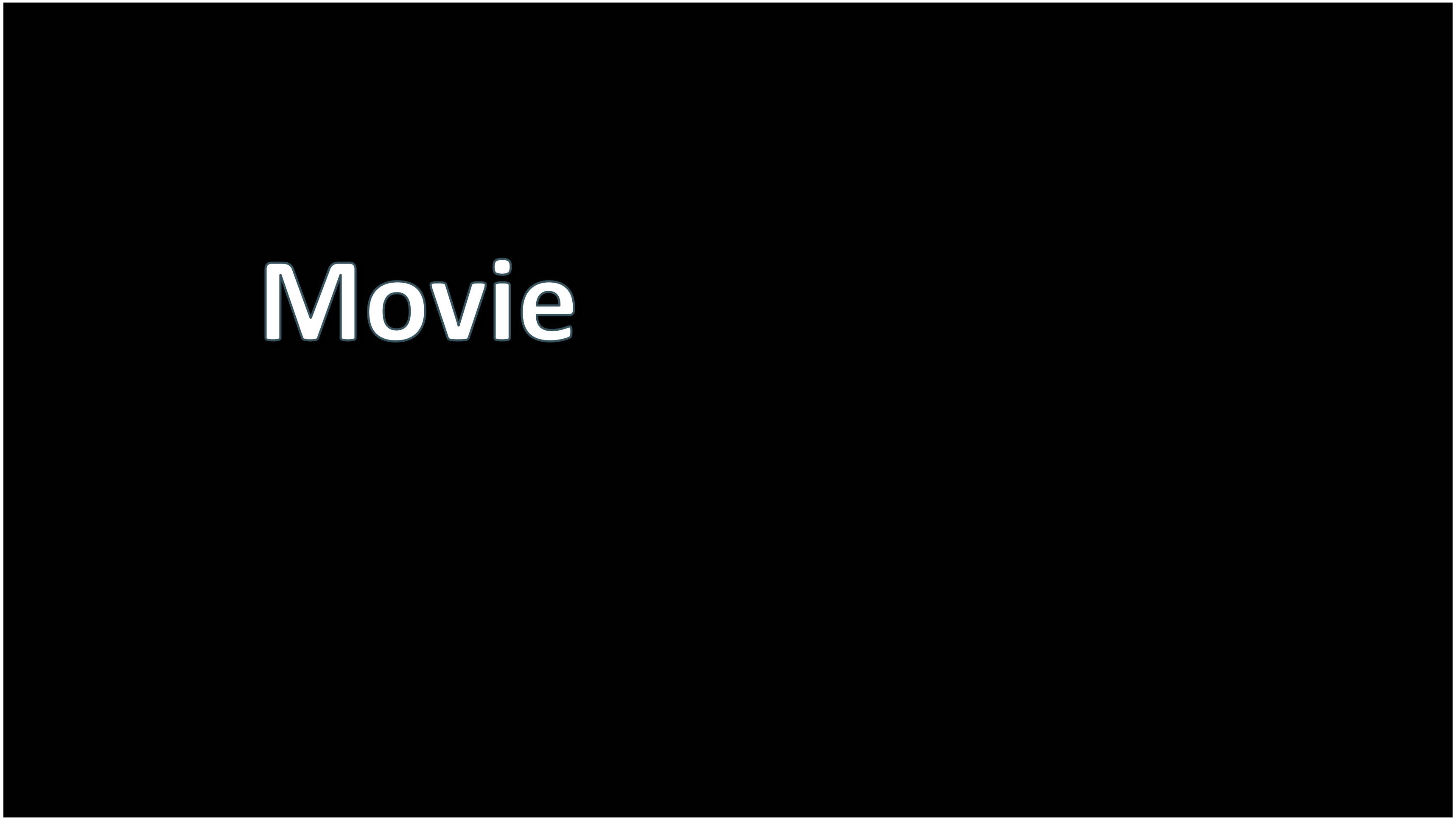
- Standard lidar
- 50mp Hassleblad Camera
- Intertial navigation system and twin DGPS
- 30 km in an hour

Helicopter-based lidar

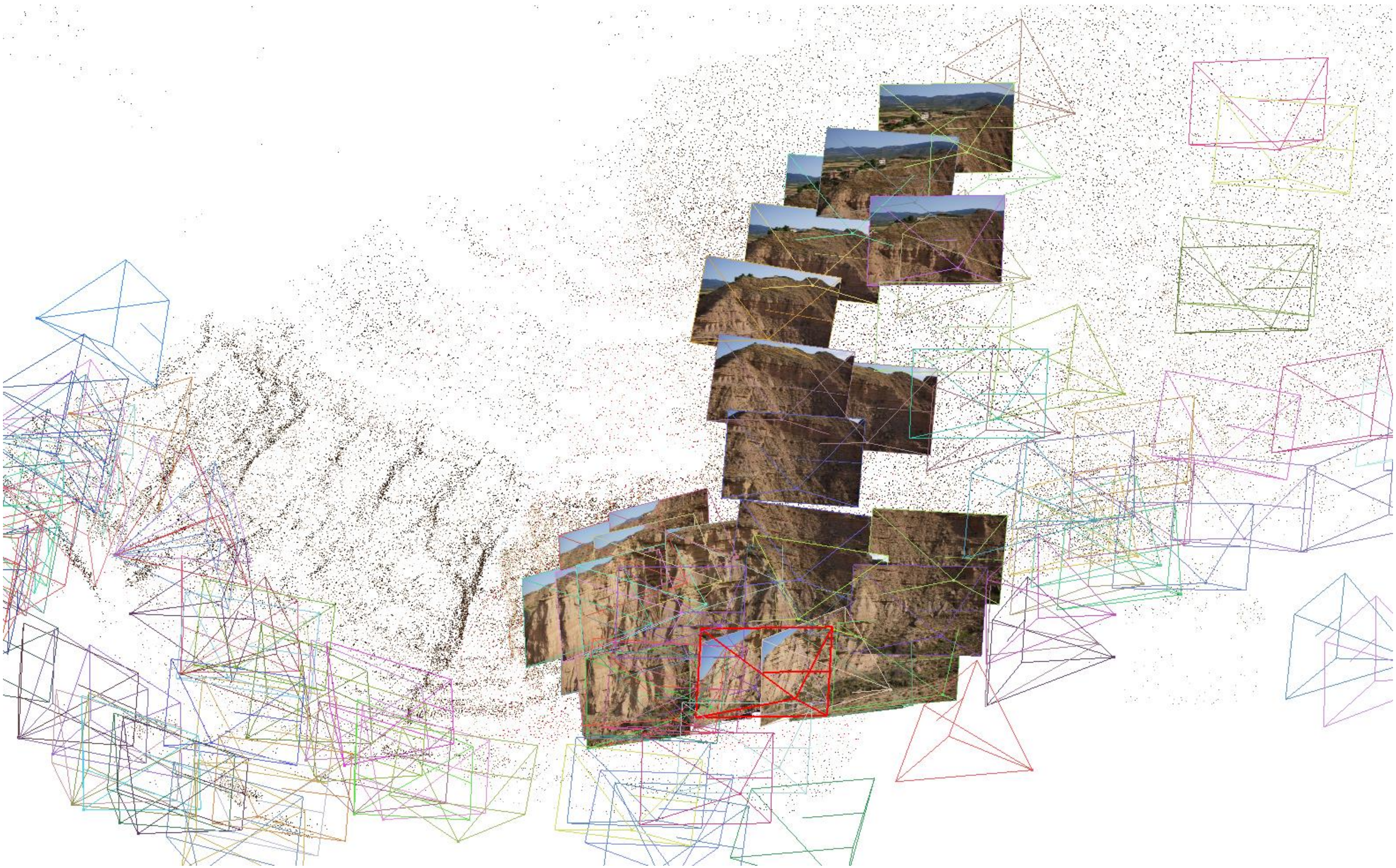
- Very large datasets are generated
  - Millions of points
  - Hundreds of digital images (at 50 megapixel – 150mb in TIF format!)
- Hardware limitations when visualising image texture
  - Difficult to get large-area overviews for geological interpretation
- Google Earth-style multi resolution processing algorithms developed
- Sections >10 km long, hundreds m high

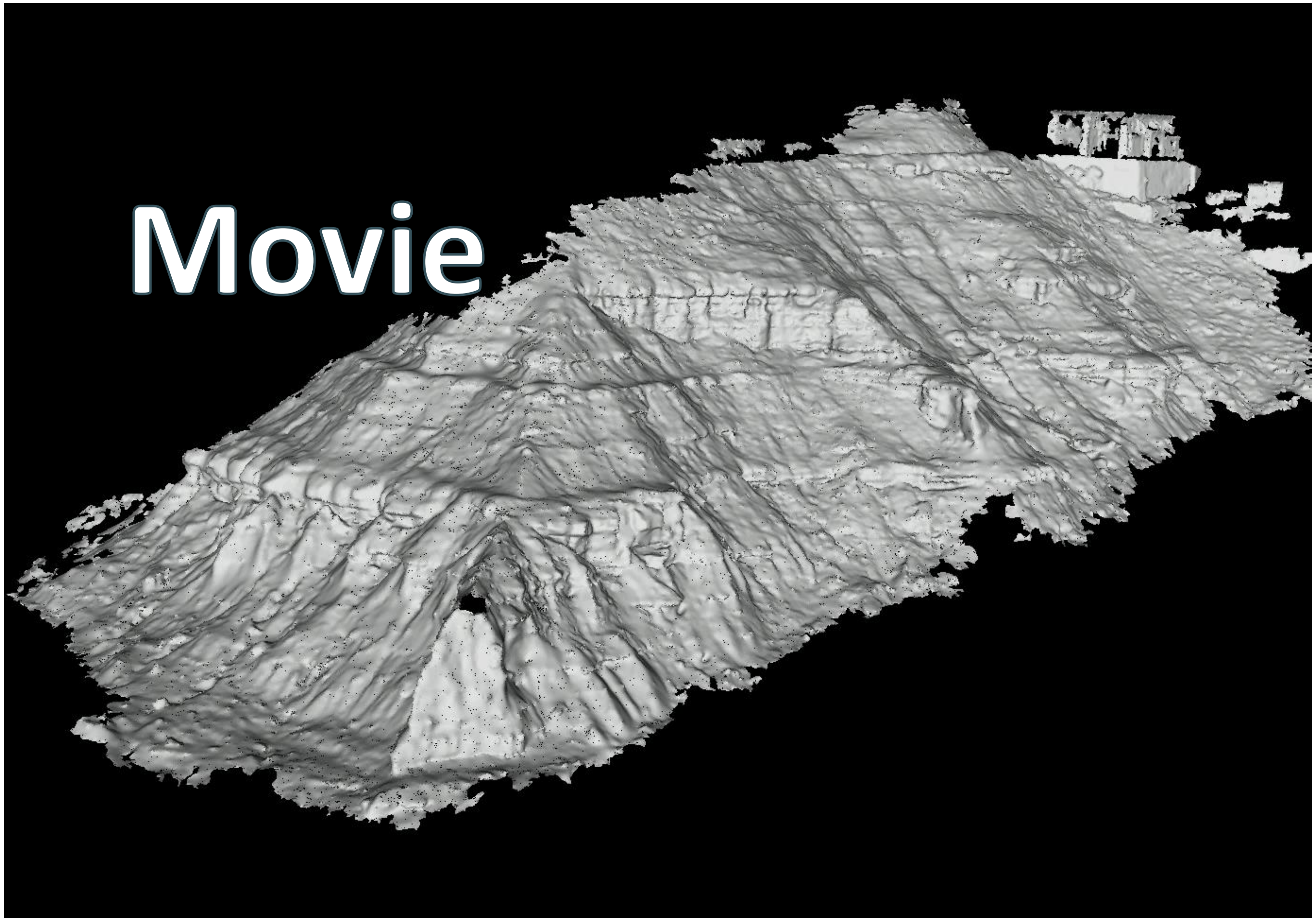


Possible solution…

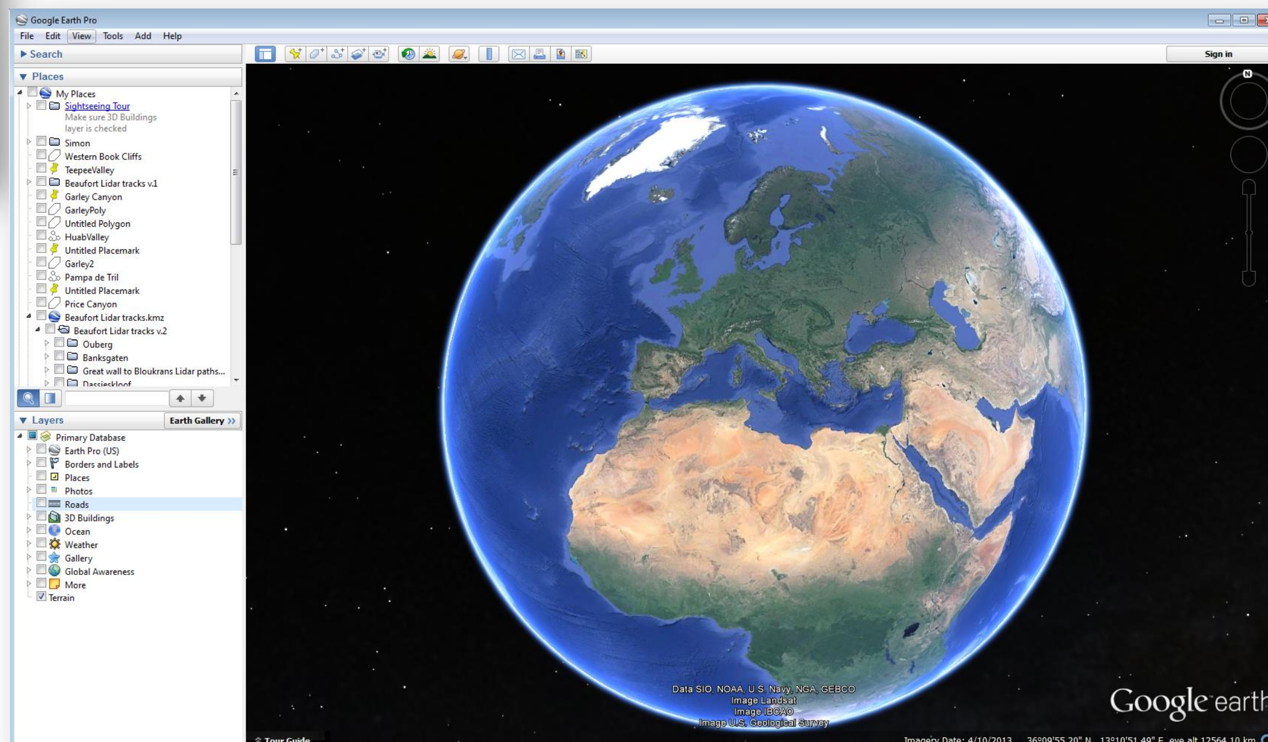

Movie

Photogrammetry

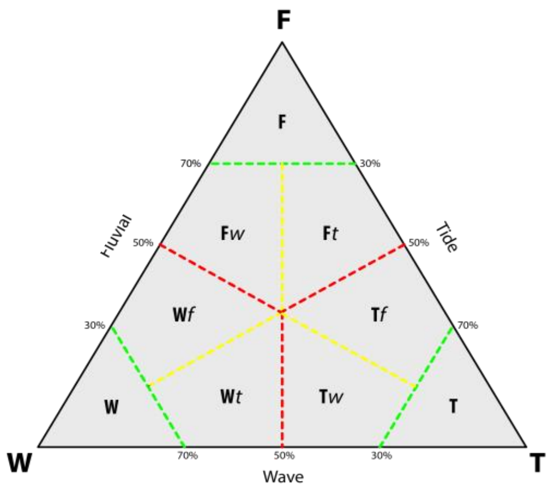



Movie

Modern Systems as analogous

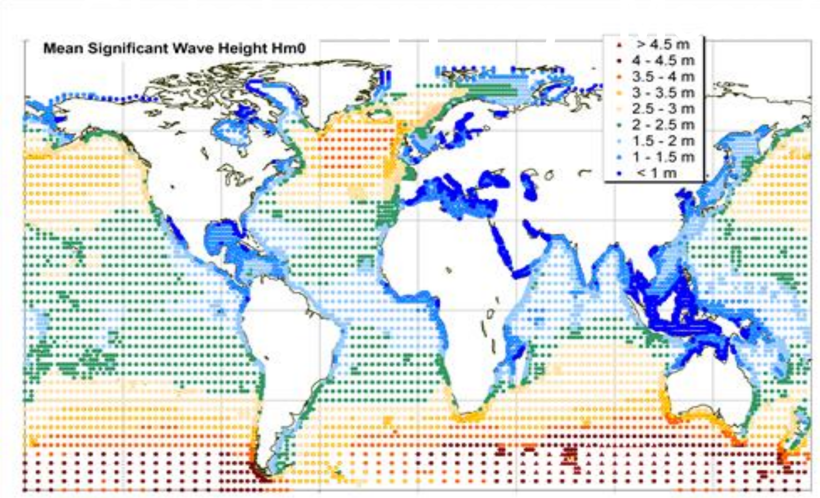


Marginal marine shoreline types (WTF)

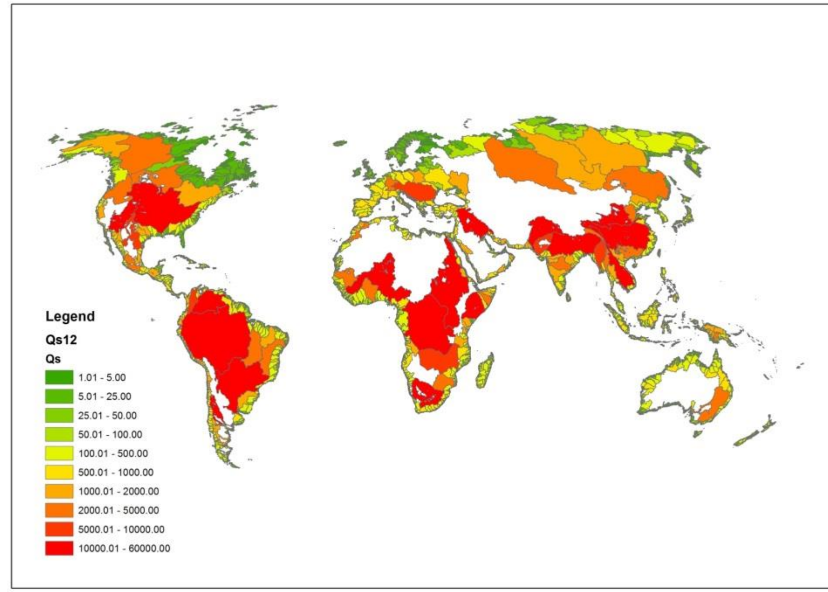


Ainsworth et al., 2011, after Galloway,1975

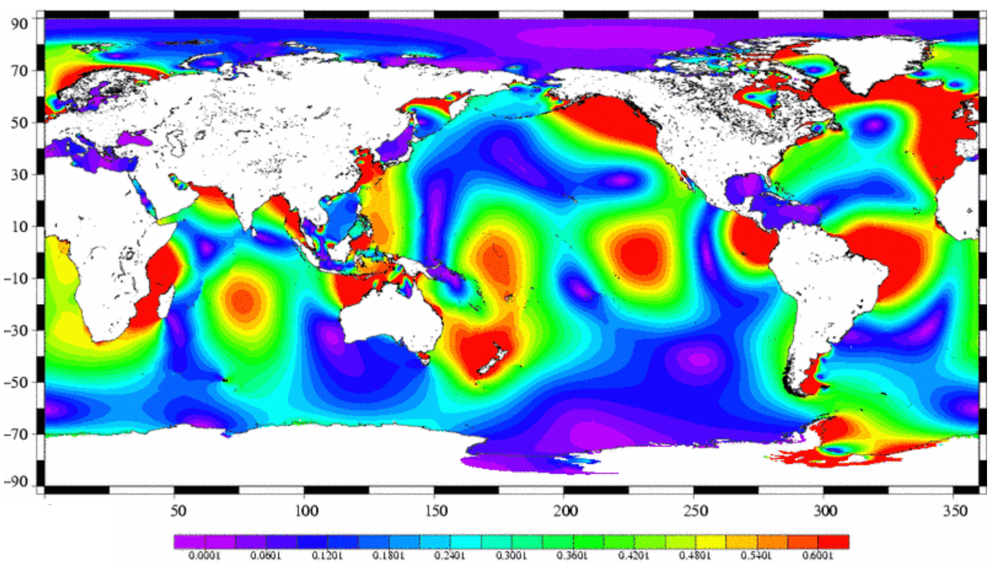
Marginal marine shoreline types



Fugro WorldWaves Global Offshore Database

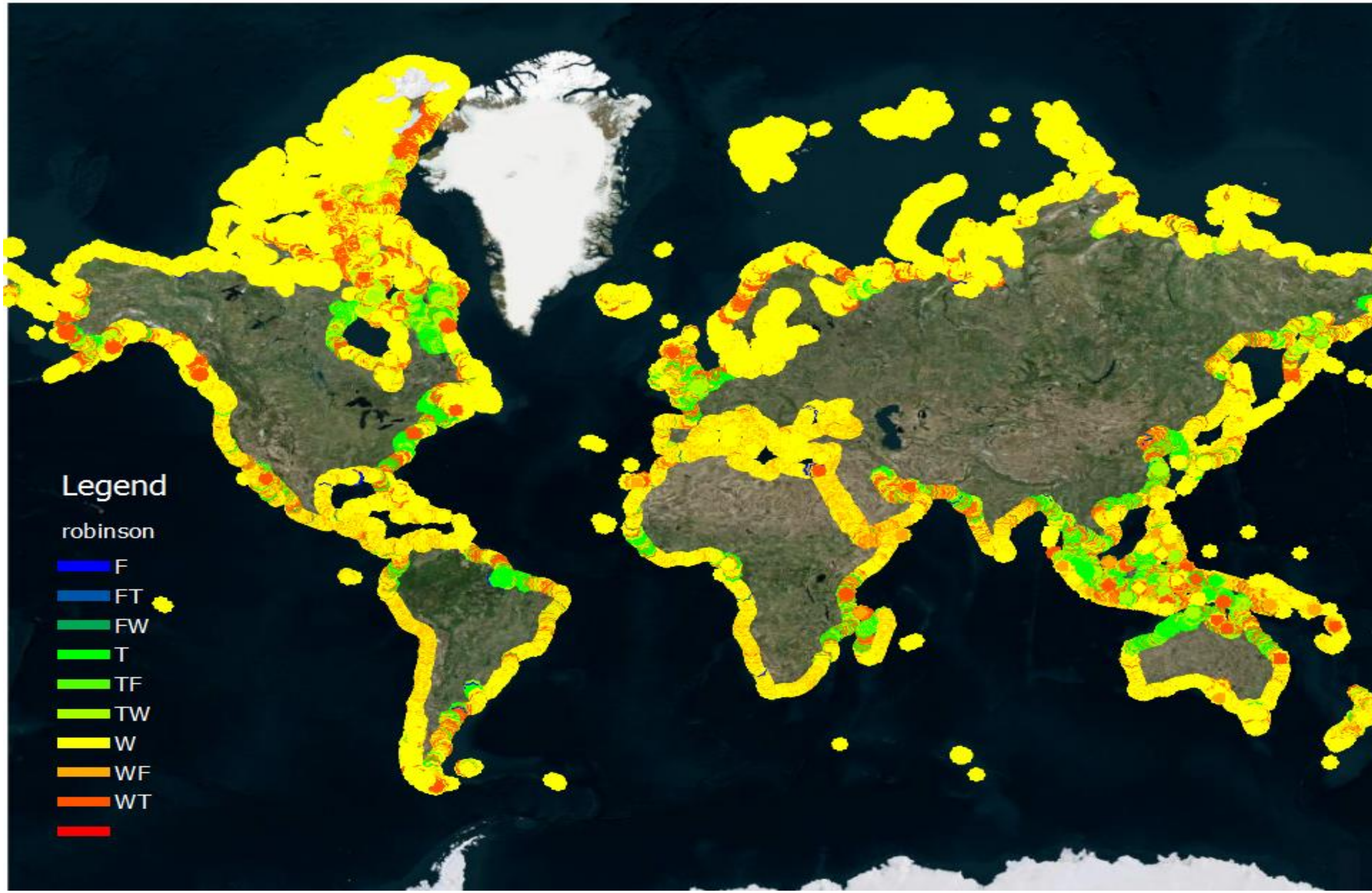


Syvitski, J.P.M., Milliman, J.D., 2007.



Aviso, with support from *Cnes* (http://www.aviso.oceanobs.com/)"

Marginal marine shoreline types



Outline

Why use analogues at all?

How we used to do it

How we do it now

- Collecting analogue data
- **Disseminating data**

The future …

Disseminating analogue data to the end user

SAFARI | Home | Data | Browse | Standard | Wiki | Modern | About | Control Panel | Support | Log out

Welcome

SAFARI is an on-going research project at Uni Research CIPR and the University of Aberdeen supported by a consortium of 23 Oil Companies, the Research Council of Norway and the Norwegian Petroleum Directorate.

The goal of the SAFARI project is to develop a fully searchable repository of geological outcrop data from clastic sedimentary systems for reservoir modelling, exploration and to improve our understanding of sequence stratigraphy. SAFARI includes data collected by the original SAFARI project in the late 1980s and early 1990s, data collected more recently by the VOG Group at Uni Research CIPR, data from published literature and data from partner organisations. Data within SAFARI are available to Sponsors and Partners. To become a Sponsor or Partner contact John Howell, Nicole Naumann or Simon Buckley

Use the tabs below or the ribbon at the top to navigate the site. For an introduction to the content of safaridb.com, visit touring page (here).

Tweets Follow

Safaridb @Safaridb 13 Mar
Excellent field session in England this week. Three new virtual outcrops collected

Safaridb @Safaridb 11 Mar
SAFARI team is LiDAR scanning three UK outcrops this week (Alport Castle, Brimham Rock and Mam Tor).

Tweet to @Safaridb

Geometric Data
Extract and analyse geometric data on architectural elements.

Knowledge Base
Wiki pages containing information on architectural elements, depositional environments and reservoir modelling.

Modern Analogues
Find a map view of a modern analogue.

Browse Outcrops
Browse and search a complete list of outcrops in the db.

Standard
Access and download the SAFARI standard.

About
General information and tour of the Safari project.

Copyright © 2010-2015 - Uni Research CIPR and University of Aberdeen

Geometric data search

SAFARI HOME DATA WIKI BROWSE STANDARDS ABOUT CONTROL PANEL SUPPORT LOGOUT

Home / Architectual search

Architectural search

Help

Gross Depositional Environment

- Continental(616)
- Paralic and shallow marine (228)
- Deep marine (575)

Outcrops

- Price Canyon (61)
- Roan Cliffs (105)
- Nine Mile Canyon (37)
- Mancos Canyon (11)
- Escanilla-Olson (230)
- Atane, Paatuut (140)
- Whitby, Cleveland basin (32)

Select a Depositional Environment

- Alluvial (616)

Climate filter (optional)

- Warm Temperate Climates C (183)
- Arid Climates B (433)

Select a Sub Environment

[?]

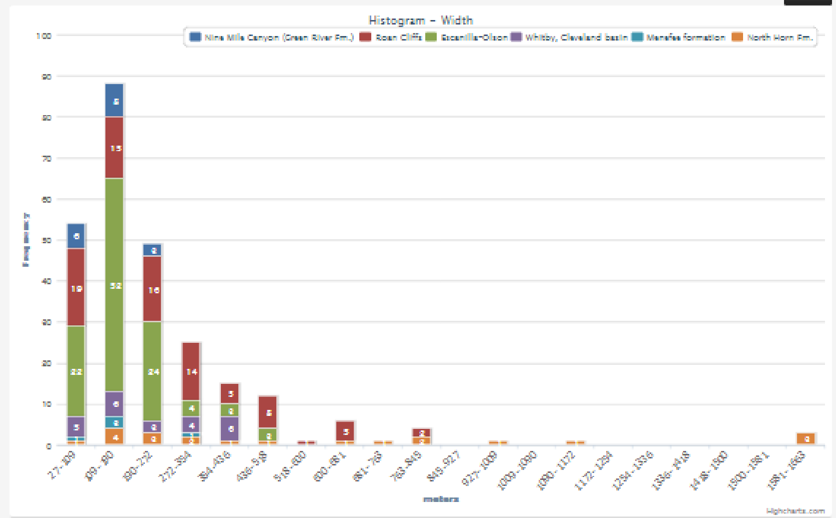
- Fluvial (616)

Select Architectural Element

[?]

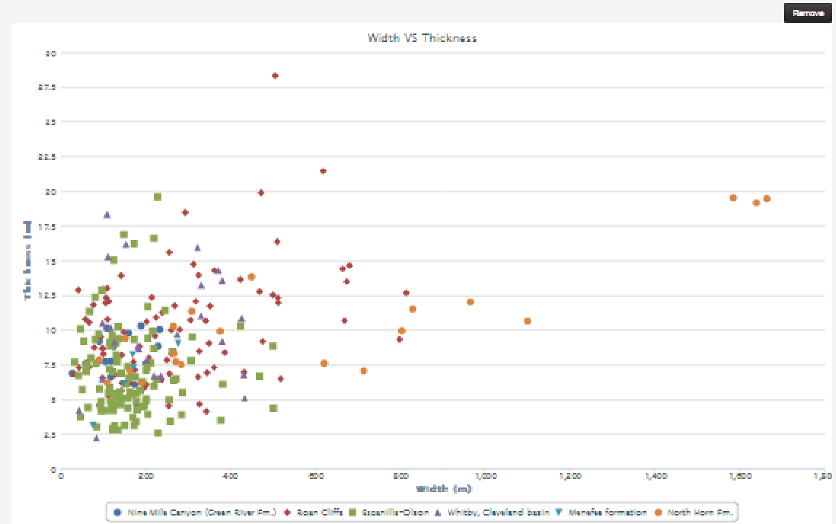
- Channel belt, undifferentiated fill (150)
- Channel belt, SingleStorey-Unilateral (64)

Remove

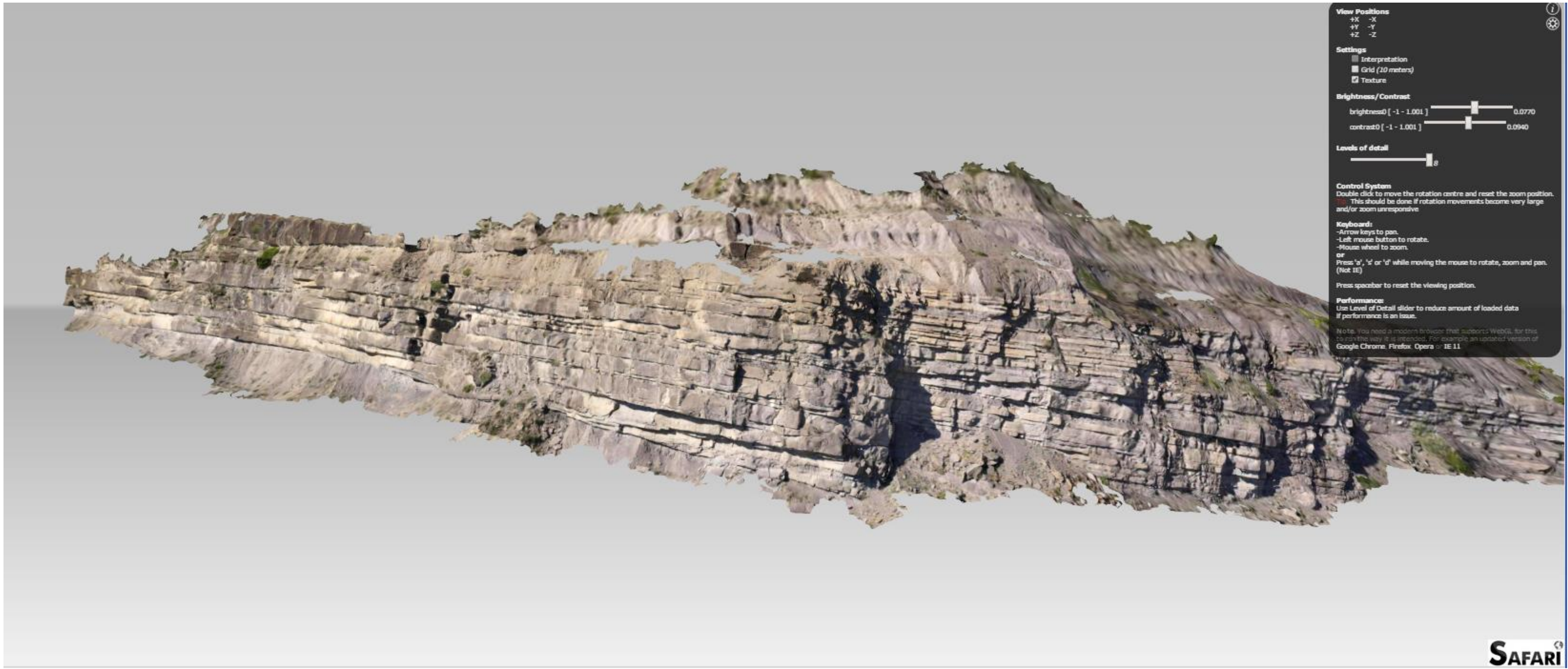


p10	p50	p90	Regression	Architectural elements in result
81.75	174.93	471.63	y = 5.97x + 175.59	260

Remove



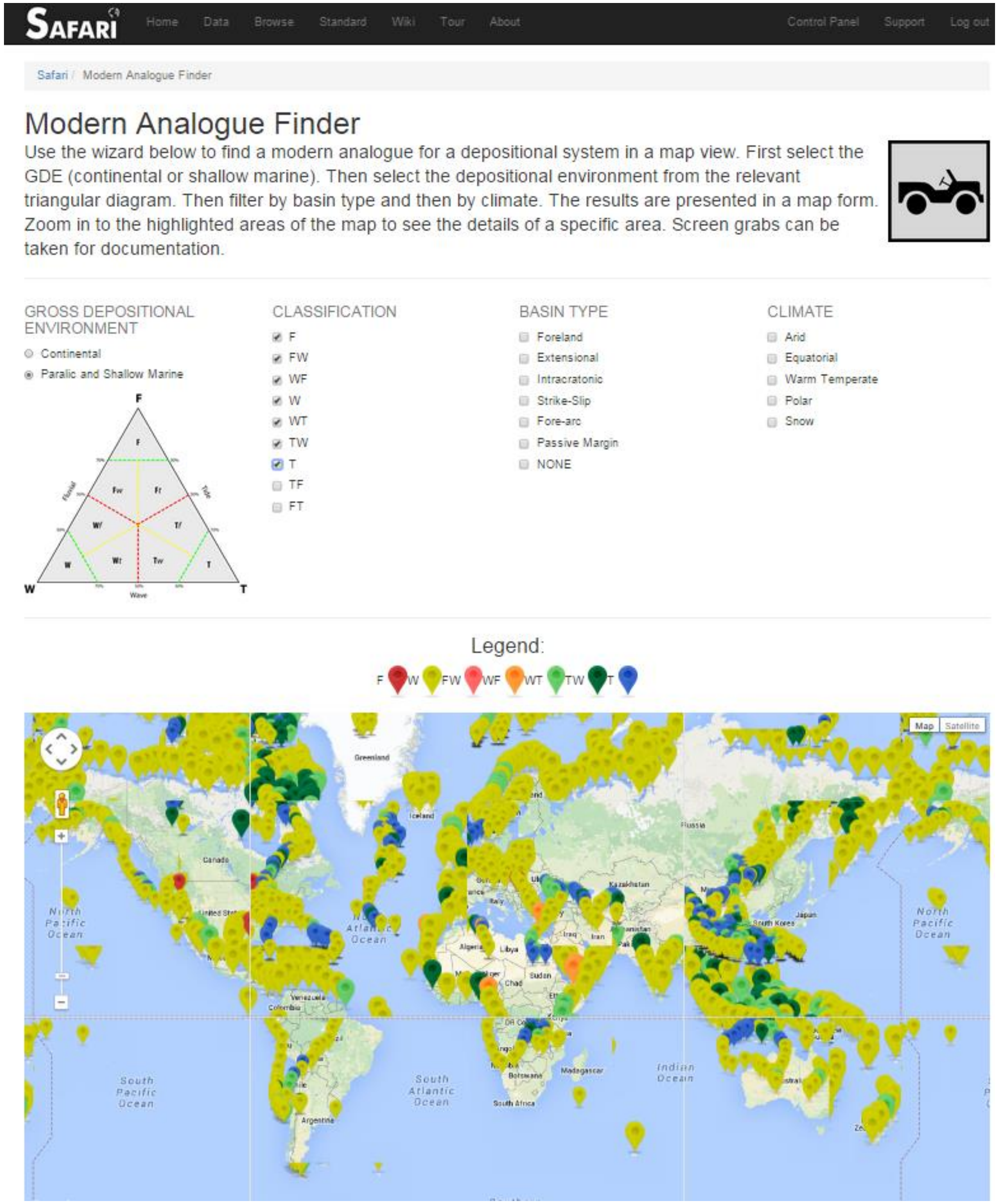
Web viewer for virtual outcrops



Allows geologists to go on a mini-fieldtrip from their desk

Web based, no software to install

Modern systems – find that analogue



Outline

Why use analogues at all?

How we used to do it

How we do it now

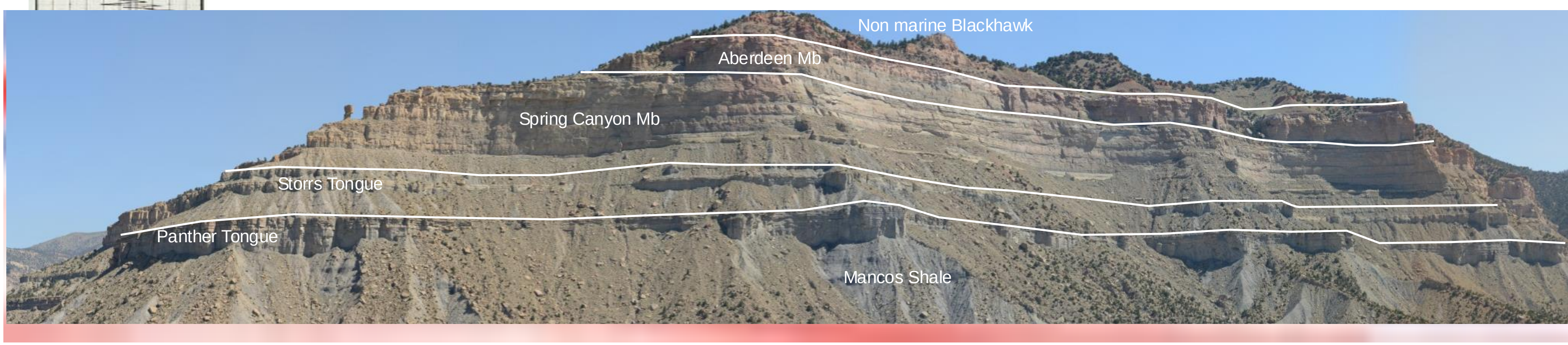
- Collecting analogue data
- Disseminating data

The future …

In the Field

- **Much greater uptake of digital data aquisition and Integrated software packages on tablets**
    - Tablets where you take photos and create your 3D virtual outcrop in the field instantly
    - Recording your position and all the samples you have collected, logs photos etc, ,
    - Overlay your interpretation directly on to the 3D model
    - More use of voice activation
- **Smaller faster laser scanners and in increased use of photogrammetry**
- **Better UAVs**
    - Longer battery life and longer range
    - Fully programable
    - Wider range of cameras – potentially hyper spectral
- **Mini lab facilites in the field for immediate mineral analysis**

Teaching and augmented reality



Conclusions

University of Aberdeen

- Analogues are still a key tool for understanding the subsurface
- In the last 15 year there has been a digital revolution in data collection including laser scanners, UAVs, Hyper spectral scanning and GIS
- Its only just started and its going to get a whole lot better...

Sponsors

www.safaridb.com

SAFARI