A Hitchhiker's Route Map to Geophysics and Geophysicist

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Australian Society of Exploration Geophysicists

Note to Users

This presentation is for the benefit of students of geophysics and those interested in geophysics.

It is free and even encouraged to copy and distribute among friends. You are also welcome to edit or add more contents to improve this.

However, if you edit to distribute, please send me a copy as a matter of courtesy. My e-mail address is: koya@terra-au.com.

Enjoy the world of geophysics.

Koya Suto, author,
(SEG HL, 2017; ASEG President 2013-14)

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A

Geophysics

1. **Introduction**
   What is geophysics ? What is the use?
2. **Geophysical Methods**
   How we use geophysics ?
3. **Geophysical works**
   Where the geophysicists work?
4. **What to study to become a geophysicist**
5. **Geophysical frontier**

Geophysics

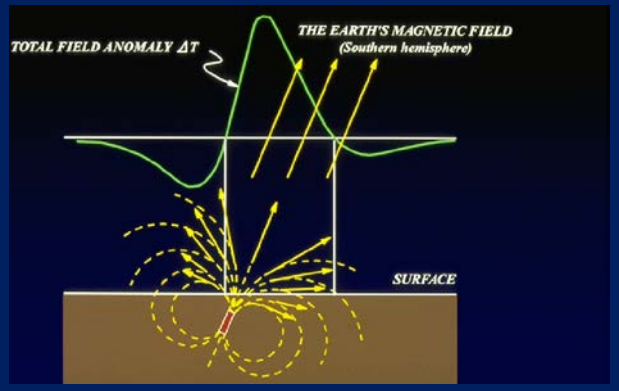
This Presentation

- Prepared for those who know and don't know geophysics
- Tell you what geophysics is – not an important part

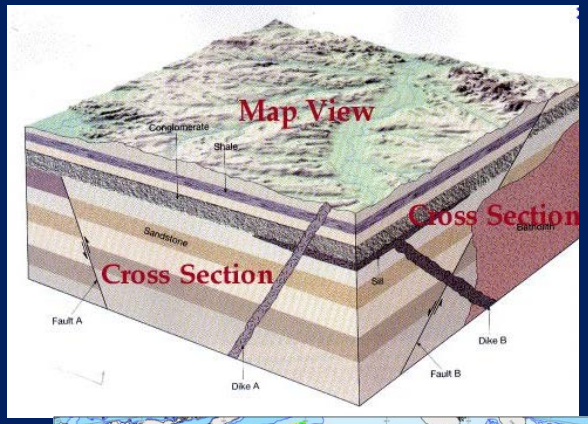
Important message I want to convey are:

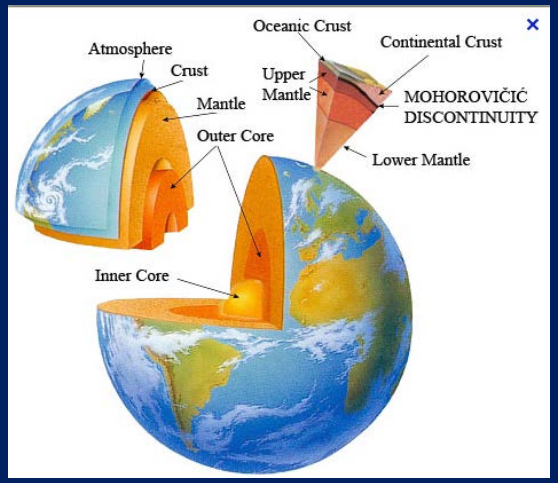
- How interesting geophysics is
- How to study geophysics
- How interesting a geophysicist's life is

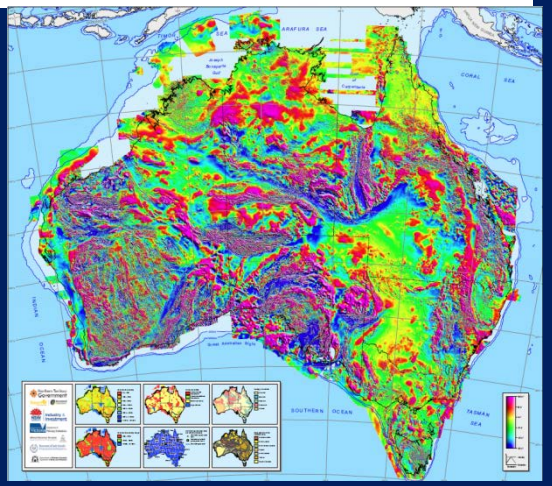
Geophysics



Let's Start



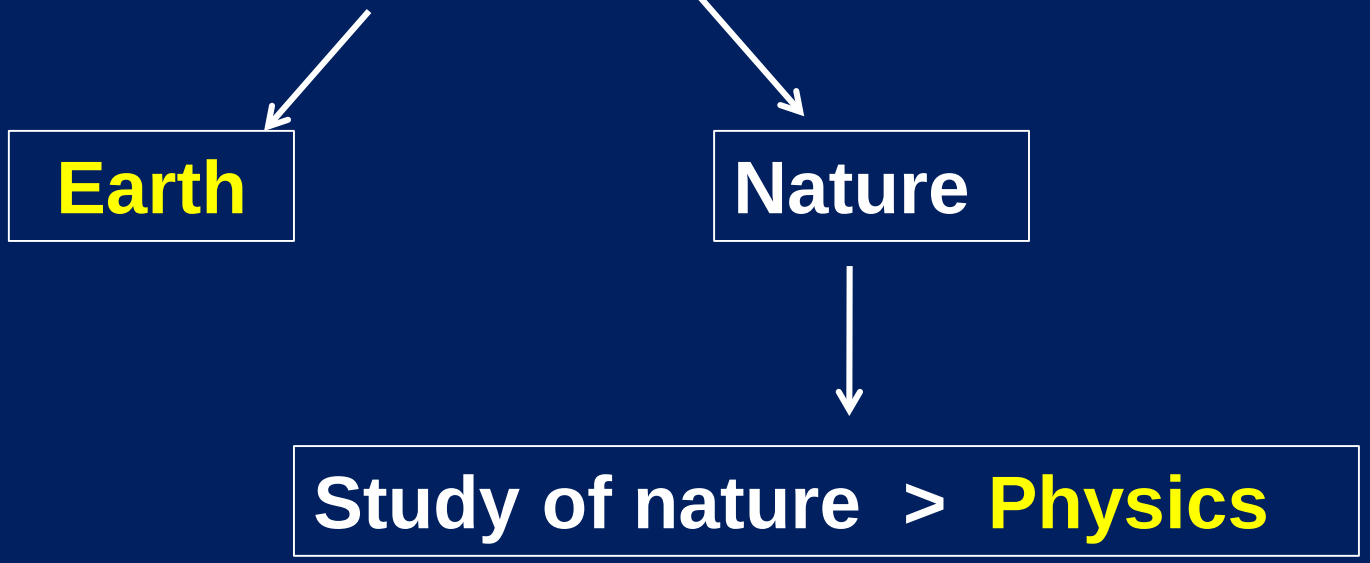




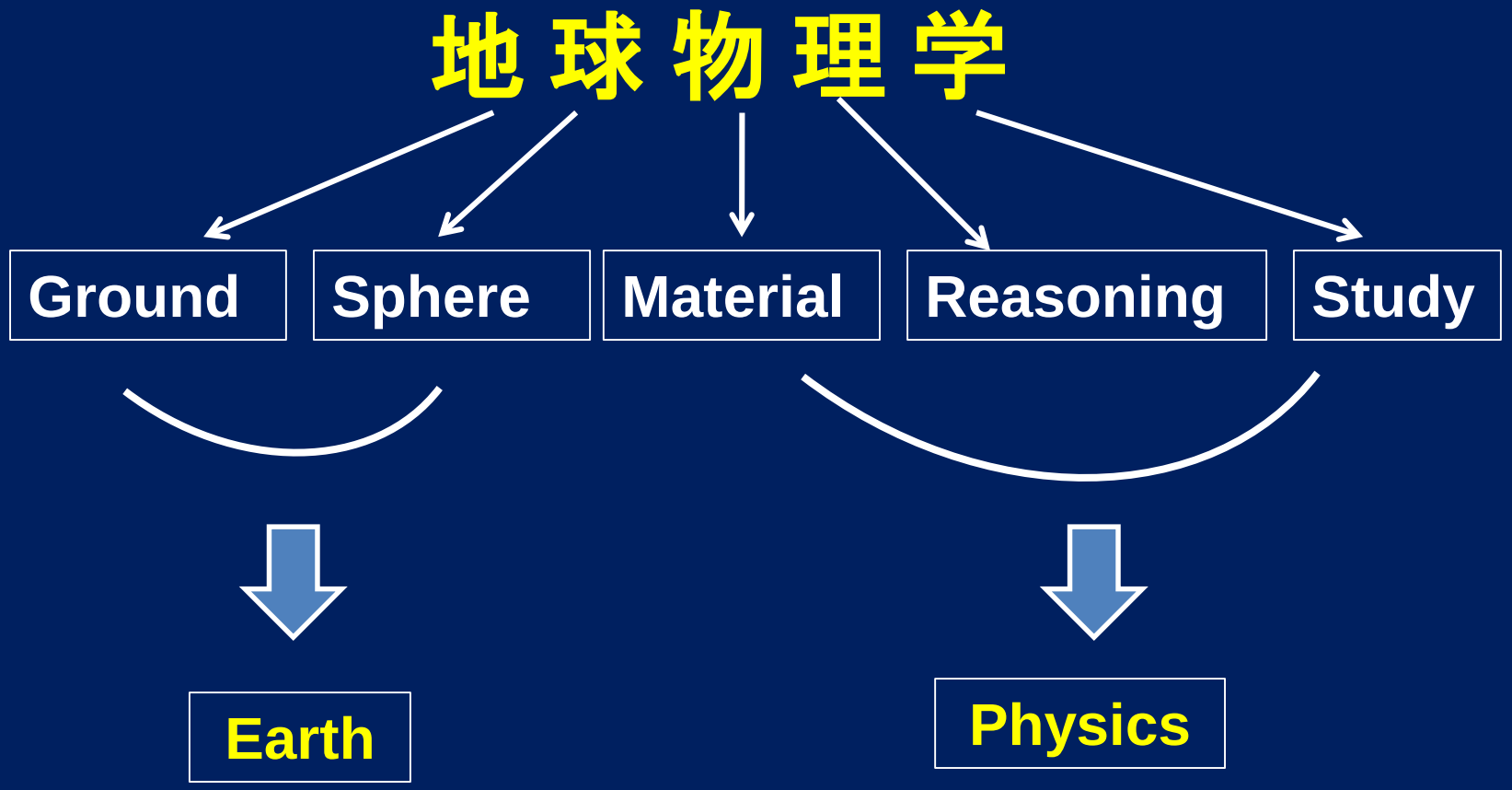
What is Geophysics

< Greek Γεωφυσική

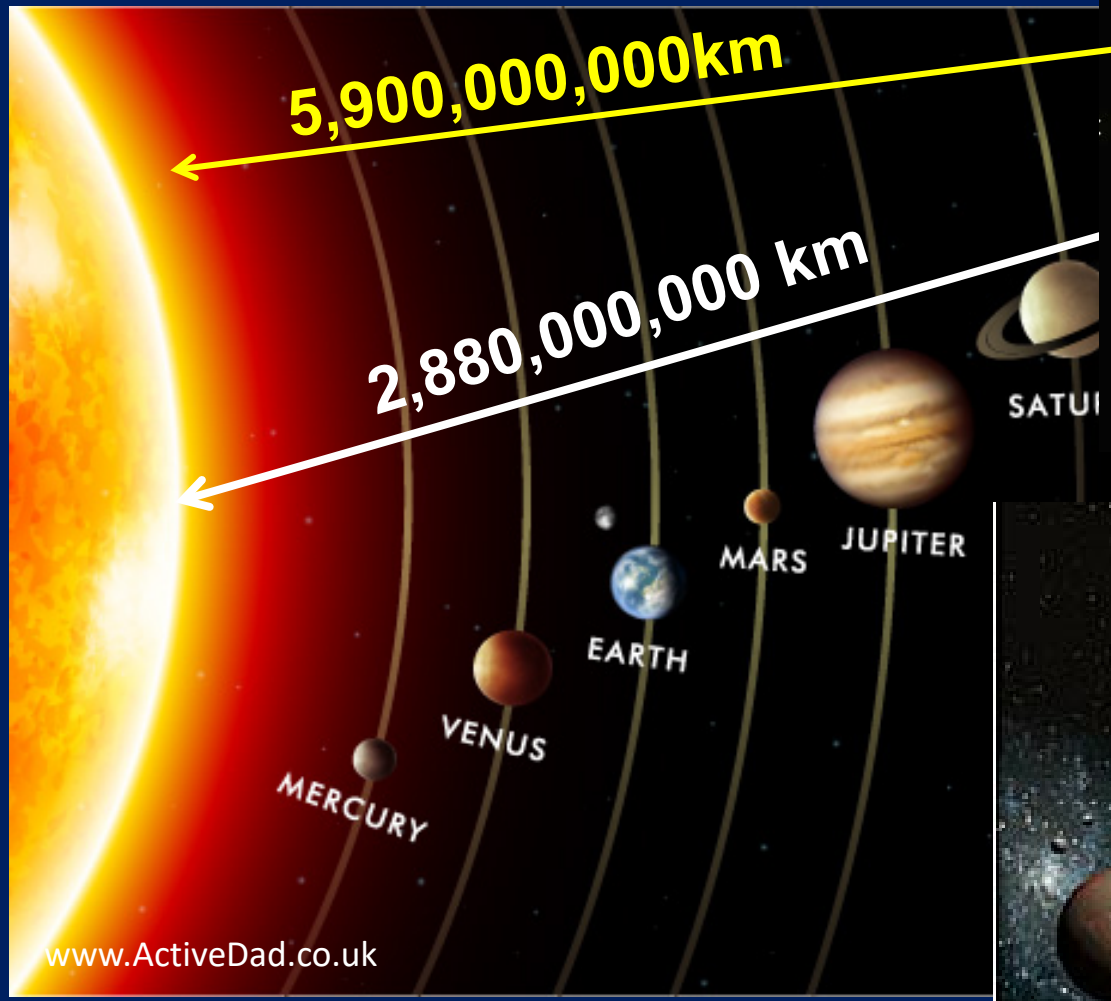
Γεω - φυσική

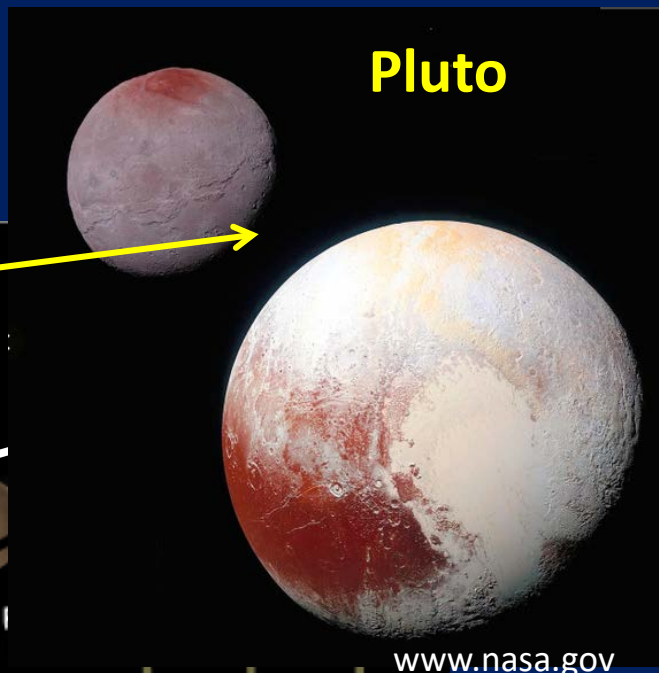


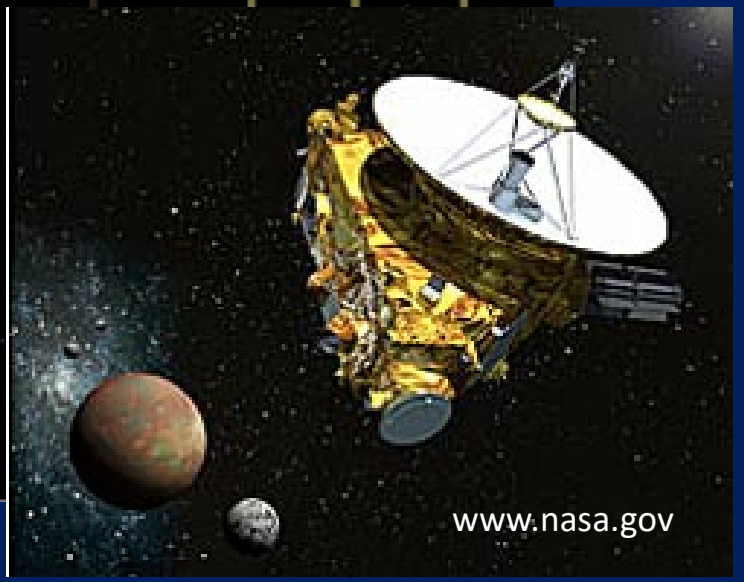
Japanese / Chinese:



Physics : Study of nature







Science : Pursuant for knowledge

We try to “see” the world.

Millions of kilometres away !

But …

We cannot see even behind a thin wall.

Science : Pursuant for knowledge

We cannot see even behind a thin wall.

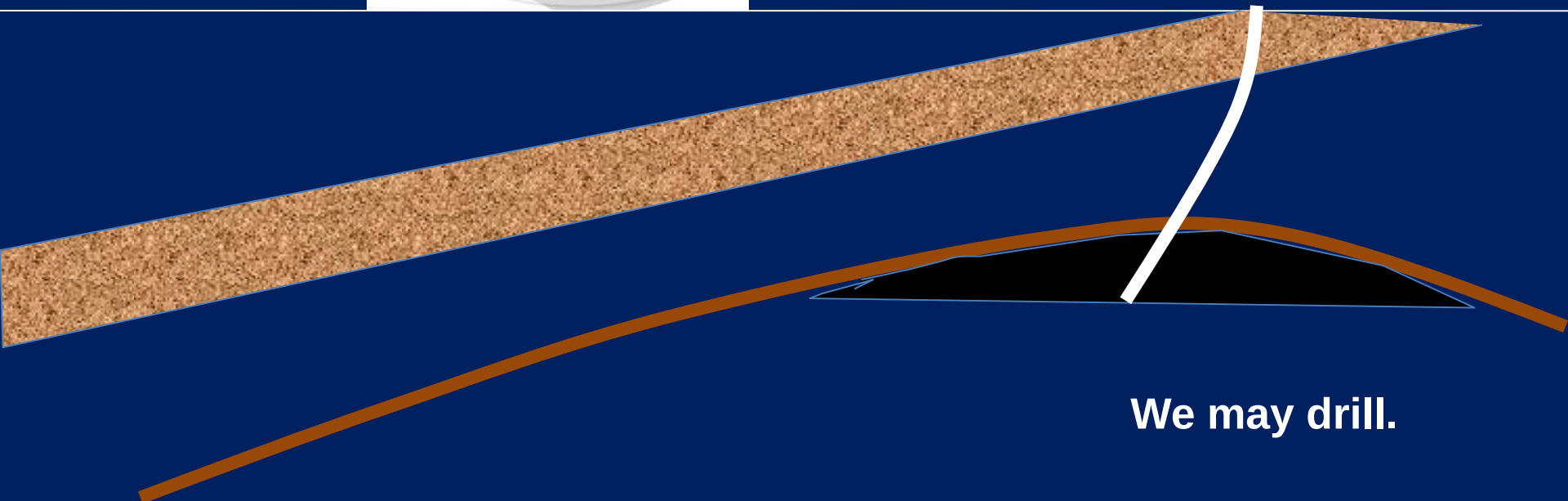
Geoscience : Science of the Earth

We cannot see even a few centimetres under the ground.

Geoscience : Science of the Earth

Geologists sample rocks and measure the dip

Geoscience : Science of the Earth



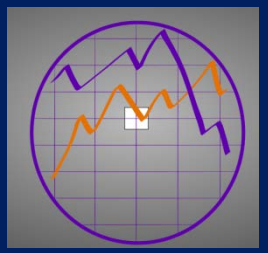
We may drill.

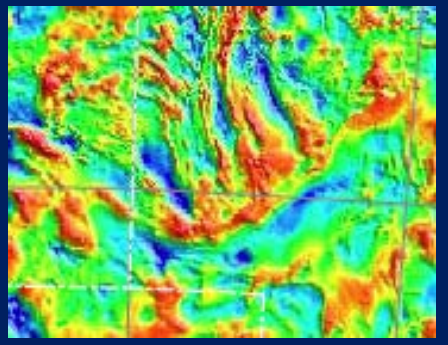
Geoscience : Science of the Earth

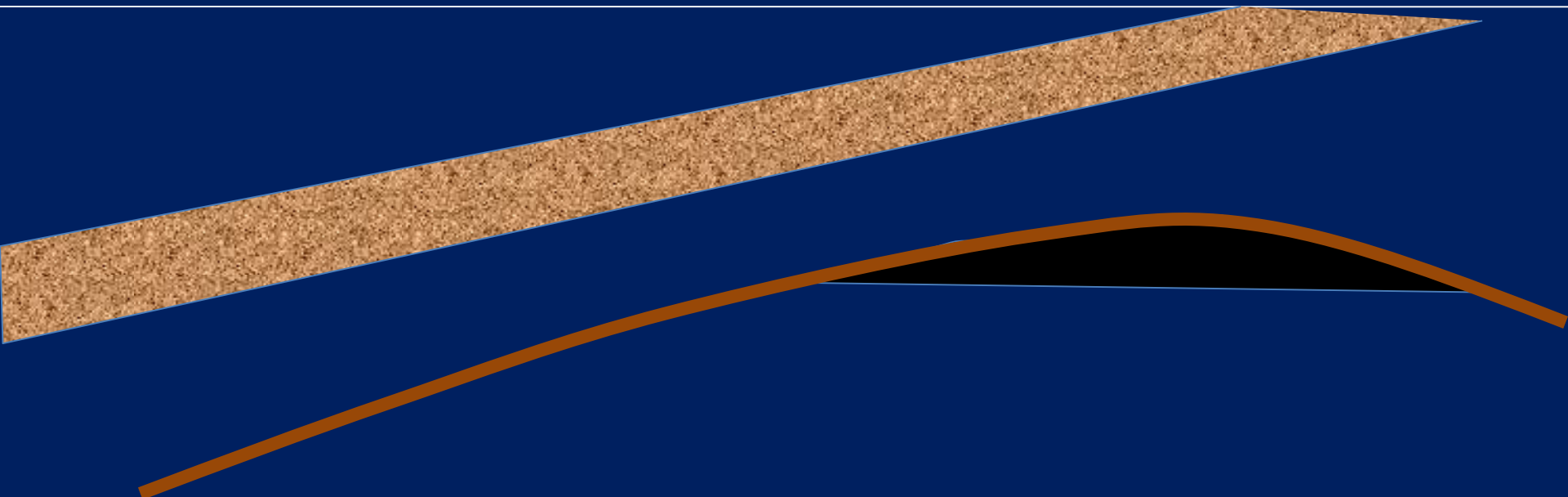
We may excavate.

Geoscience : Science of the Earth

Geophysicists measure and map physical properties







Geophysics Геофизика Γεωφυσική 地球物理学

Study of nature > Physics

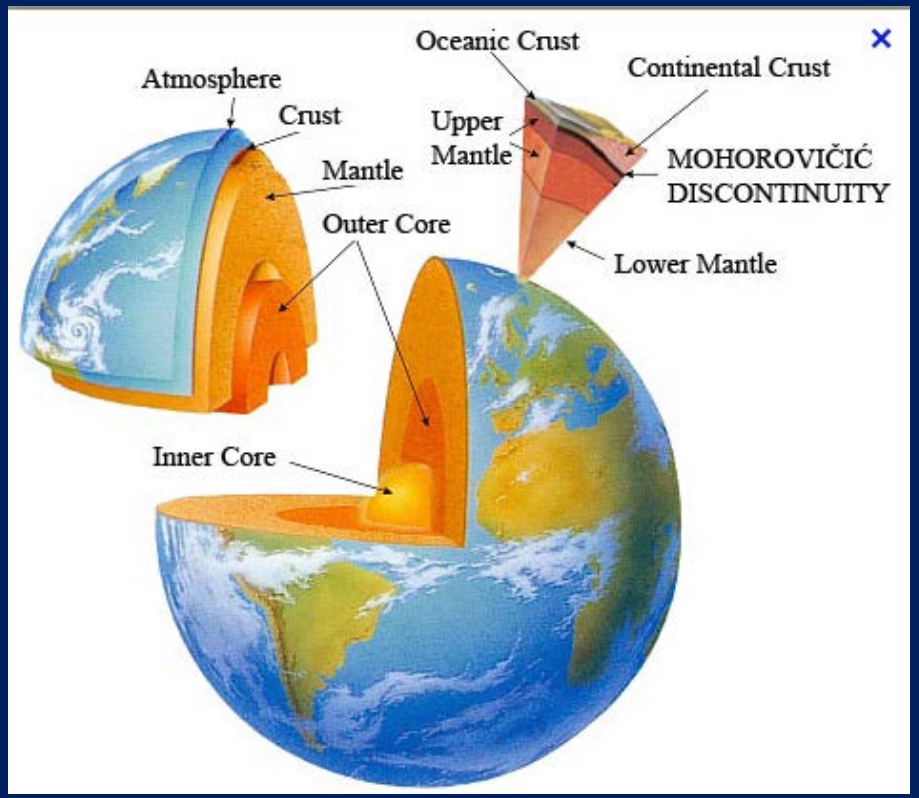
Geophysics : Study of nature of the Earth

Geophysics : Study of nature of the Earth

It is a technique or group of techniques to “see” the invisible part of the earth through its physical properties.

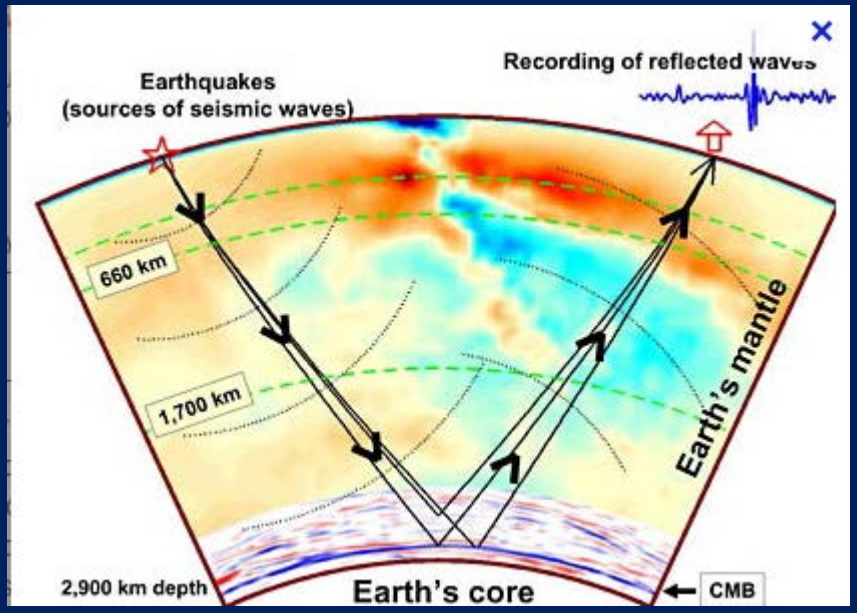
Huge Scale – to 6500km deep

Solid earth geophysics



www.thisoldearth.net

Research of earth's interior



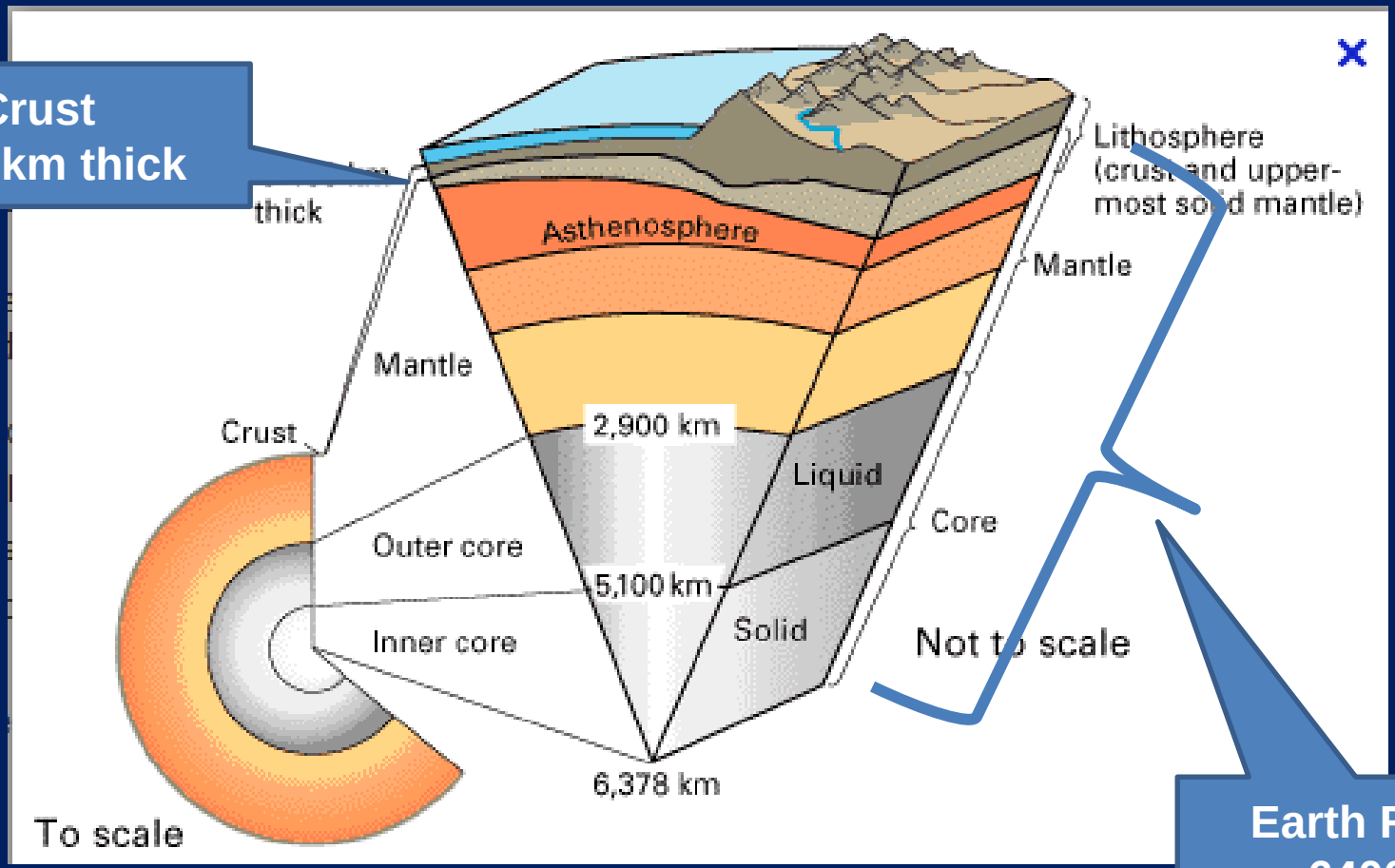
Web.mit.edu

Large Scale – 10 - 50km deep

Earth's Crust

Plate tectonics
Earthquakes
Volcanoes

Crust
10-50km thick



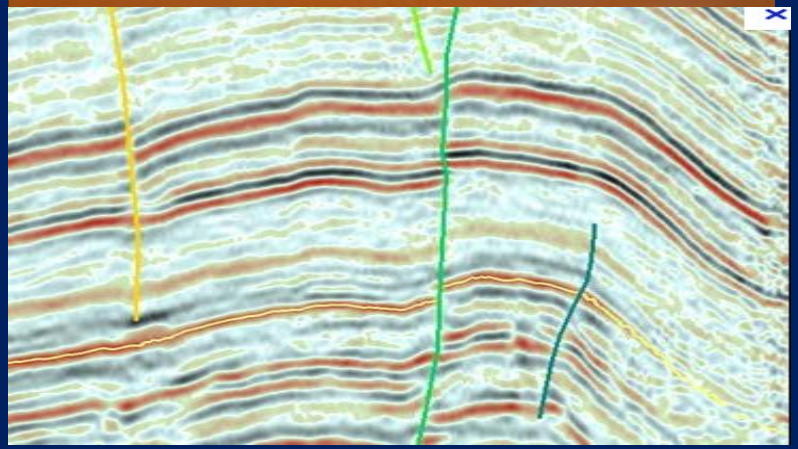
Earth Radius
6400km

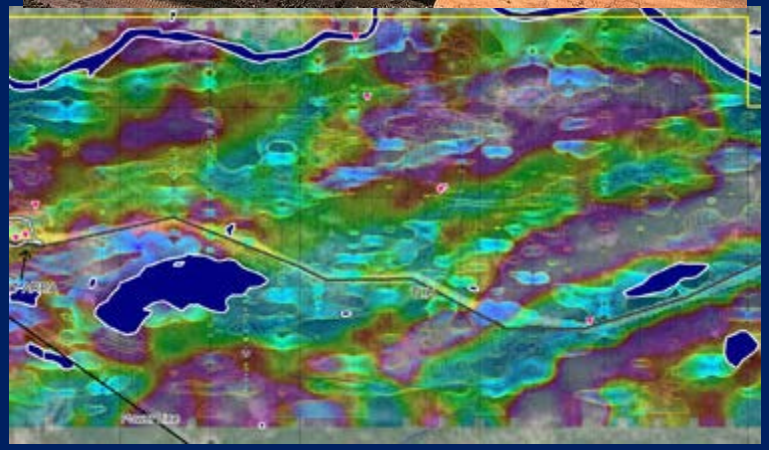
Skolor.nacka.se

Medium Scale - to ~6000 m

Exploration geophysics

Looking for Earth's Resources





Small Scale - to 100m Engineering Geophysics

Within the region of common human activity

Is the ground firm enough to support these structures?

Geophysics : Study of nature of the Earth

It is a technique or group of techniques to "see" the invisible part of the earth through its physical properties.

Why do we study geophysics ?

Science - Pursuing the unknown

- It is interesting.

Economic interest - Looking for new resources

- If you find something, the reward is big

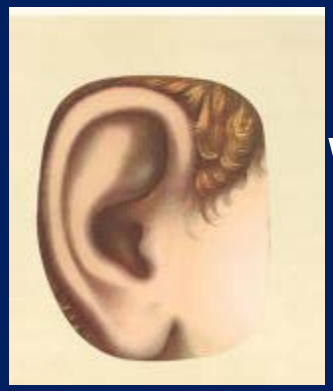
Safe human environment and community development

- Contributing to safe construction and disaster mitigation

What do we see?

We see light with our eyes.

www.rbiser.com



www.slite-view.com

We hear sound with our ears.

Physical Phenomena

We smell with our nose.

Chemical Stimulation

www.lifesizestatue.com

To “see” **Collect information**

Sensors

We see light with our eyes.

We hear sound with our ears.

To “recognise” **Process information**

Brain

http://www.sleepwarrior.com

To “see” Collect information in geophysics

Sensors

Electronic Instruments

To “recognise” Process information

Geophysical Algorithms on Computers

What does geophysics use to try to “see”?

Any physical phenomenon around us

Light - Colour

Sound – or any vibration

Mass - Gravity

Electric – current voltage resistivity

Magnetic potential

Electromagnetic Induction

Heat - Temperature

Radiation

Geophysics – How do we use to “see” it?

Ground Survey

Airborne

Offshore Survey

Downhole Survey

Geophysics

1. Introduction
   What is geophysics ? What is the use?

2. Geophysical Methods
   How we use geophysics ?

3. Geophysical works
   Where the geophysicists work?

4. What to study to become a geophysicist

5. Life as a geophysicist

Sign Post

2. Geophysics – Some of geophysical methods

Physical Phenomenon	Geophysical Method	Survey Mode	Target	Purpose
Vibration	Seismic	Land / Marine	Geological Structure	Petroleum Exploration
Mass	Gravity	Land / Marine Airborne	Geological Structure Heavy material Void	Minerals Exploration
Magnetic attraction	Magnetic	Land/ Marine/ Airborne	Geological structure Magnetic material	Minerals Exploration
Electric resistivity	Electric survey	Land	Conductive material	Minerals Exploration
Electromagnetic induction	Electromagnetic	Land/ Airborne	Conductive material	Minerals Exploration
Radiation	Radioactive	Land/ Airborne	Heavy minerals	Uranium Exploration
Light -Colour	Remote sensing	Airborne	Light reflectivity Heat	Environmental Vegetation

Geophysics

1. Introduction
   What is geophysics ? What is the use?

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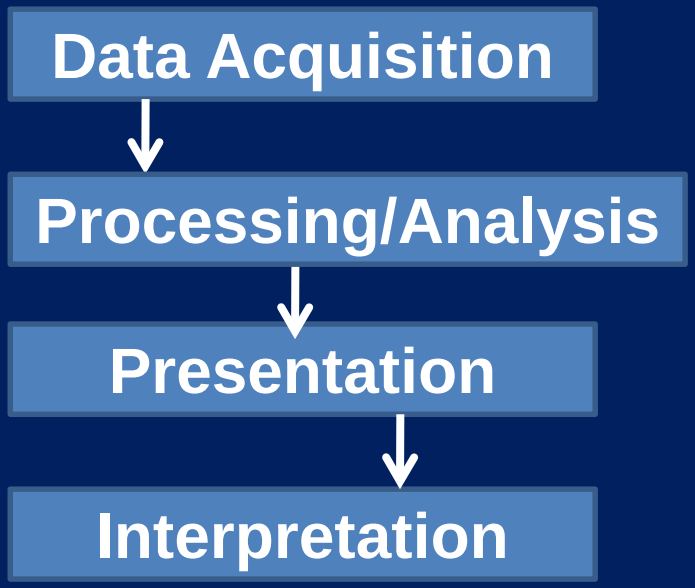
   How we use geophysics ?

3. Geophysical works -- Career Paths
   Where the geophysicists work?

4. What to study to become a geophysicist

5. Geophysical frontier

Where geophysicists work ?



Geophysicists work in each of the four steps.

Some specialised
Some integrated

Where geophysicists work ?

www.seistronix.com

Instrument Design Manufacturing

Data Acquisition

Processing/Analysis

Presentation

Interpretation

www.satimagingcorp.com

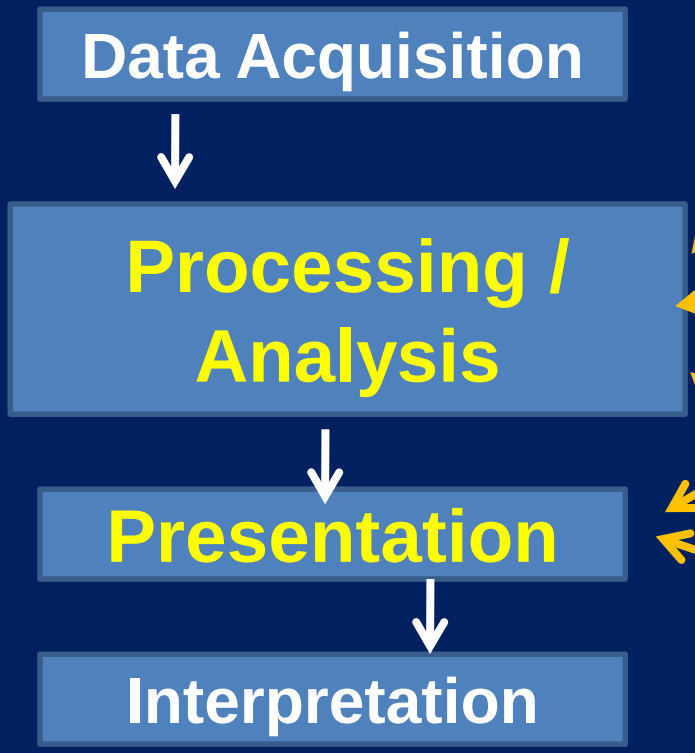
Field Operation

Data acquisition – What do we do to collect data?

Photos from Elliott GEOPHYSICS

http://www.geophysicsconsultants.com

Where geophysicists work ?



Routine Processing and Analysis

- Processing contractors
- Exploration companies
- Consultants

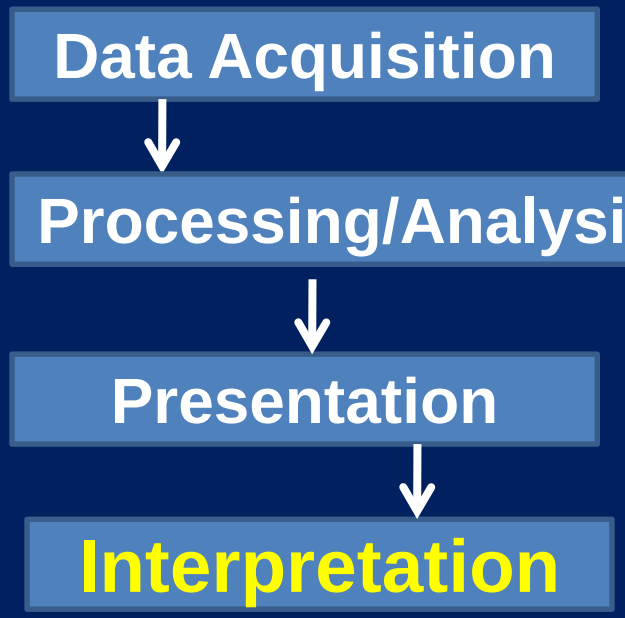
Research Theory Development

- Universities
- Research organisations
- Exploration Contractors

Software Development

- Universities
- Research organisations
- Software vendors

Where geophysicists work ?



Majority of geophysicists work in this area

Making Sense of Data

- Exploration companies
- Consultants

Research

- Universities
- Research organisations
- Software vendors

Geophysics

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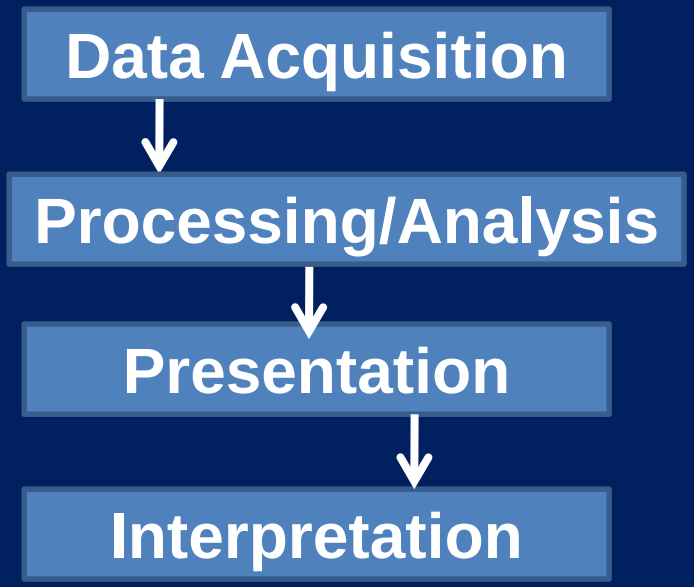
It depends what you want to do



Each stage has different emphasis.

There are common essential things to learn.

You may not get what you want.

My suggestion:

Be prepared to do anything.

Open your mind and broaden your horizon.

Some specific (additional) skills handy for each stage

Data Acquisition

Electronics - Instrumentation
Mechanics - Use of machinery

Processing/Analysis

Programming - Software Development
Computing

Presentation

Computer Literacy
Communication Skill
Psychology - Recognition

Interpretation

Geology
Production Engineering

Business

Economics
Production Engineering

Common and Essential Subjects for All the Aspects

Data Acquisition

Processing/Analysis

Presentation

Interpretation

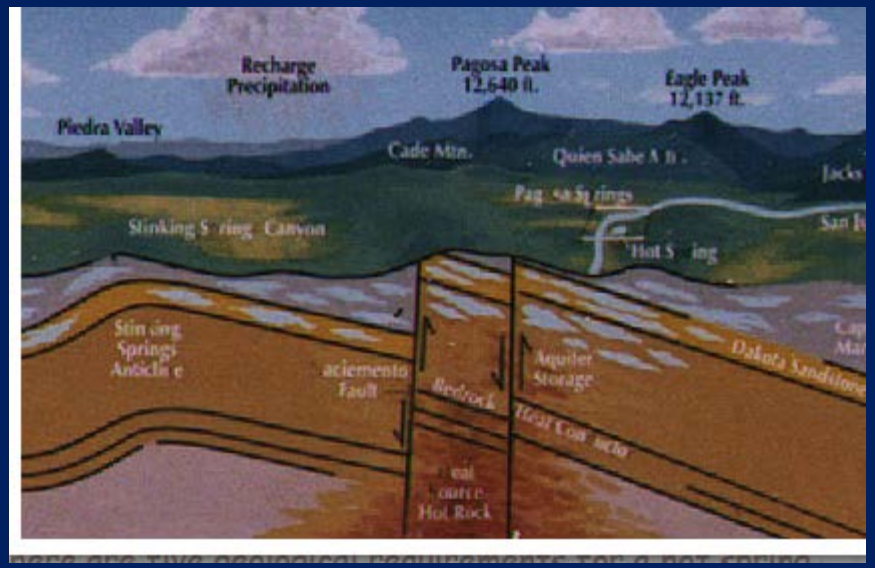
G E O P H Y S I C S

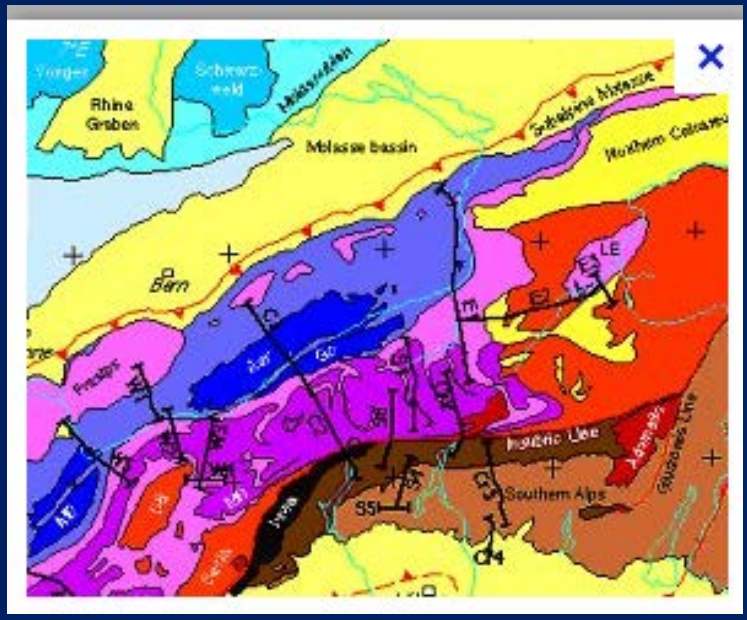
Geology

Physics

Mathematics

Geology





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www.victorianweb.org

Geology

- Broad subject based on direct observation
- Geologist think about genesis of the present state of the earth.
- Geophysical observation contributes to geological investigation...
  - By describing the present state

Geophysicists need to communicate with geologists.
Geophysicists analyse the data in terms of geology.

Physics

- Basis of geophysical development
- What aspects of physics can be used to describe the earth? Watch for it !

Essential in:

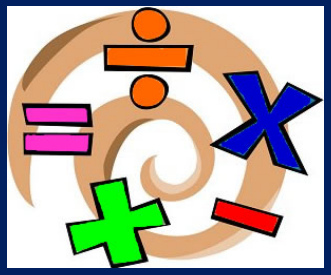
- Theory development
- Instrumentation – electronics
- Analysis algorithm - computer science

Physics and math deal with idealised world.
Geophysics deals with real world

Mathematics

Tool to solve problems.

Math uses procedure already proven, there is no room for error.



- Many students don’t like math.

- Science students who don’t like math move to biology and geology.

WHY ?

Mathematics

"Mathematics is difficult; it is scary."

Math class demands to solve difficult equations.
demands "correct" answer.

Geophysics

Does not ask to solve a difficult equation.

In many cases, we know there is no analytical solution.

If numerical solution is required, a computer will give you.

Mathematics is a language to describe the physical world.

牛郎
Niulong

牛郎 and 織女 went out for a drink.

Total bill was $36.
How many glasses did each of them drink?

織女
Zhiyu

Not enough information ?

It is always the case in geophysics.

Math and Physics

牛郎

牛郎 and 織女 went out for a drink.

織女

Total bill was $36.
How many glasses did each of them drink?

Geophysics

We measured gravity and processed data, and found the value of one point was 1 milligal higher than the surroundings.

What is under the ground and how deep?

牛郎

牛郎 and 織女 went out for a drink.

牛郎 drank some beer, 織女 drank Champaign.

Total bill was $36.

How many glasses did each of them drink?

織女

Total bill was $36. How many glasses did each of them drink?

牛郎 drank some beer, 織女 drank Champaign.

牛郎

$3 

x x

$6 

x y

織女

$$3x + 6y = 36$$

Mathematics is a language to describe the physical world.

∞

In mathematics, there are infinite number of solutions.

牛郎	織女	牛郎	織女
0	6	7	2.5
1	5.5	8	2
2	5	9	1.5
3	4.5	10	1
4	4	11	0.5
5	3.5	12	0
6	3		

Or even

牛郎	織女
-12	12
-6	9
1.33	5.335
4.735	3.6325
100	-44
-100	56
$-\infty$	∞

Total bill was $36. How many glasses did each of them drink?

$3 × x

$6 × y

$$3x + 6y = 36$$

牛郎

織女

In real world, there is a physical reality.

Number of drinks must be an integer, can't be negative.

牛郎	織女	牛郎	織女
0	6	~~7~~	~~2.5~~
~~1~~	~~5.5~~	8	2
2	5	~~9~~	~~1.5~~
~~3~~	~~4.5~~	10	1
4	4	~~11~~	~~0.5~~
~~5~~	~~3.5~~	12	0
6	3		

Or even

牛郎	織女
-12	12
-6	9
1.33	5.335
4.735	3.6325
100	-44
-100	56

$-\infty$ ∞

Total bill was $36. How many glasses did each of them drink?

牛郎

$3 × x

$$3x + 6y = 36$$

$6 × y

織女

In social scene, it is unlikely to drink all by oneself.

Physiologically, one cannot drink too much.

牛郎	織女
~~0~~	~~6~~
~~2~~	~~5~~
4	4
6	3

牛郎	織女
~~8~~	~~2~~
~~10~~	~~1~~
~~12~~	~~0~~

Likely solutions but still uncertain

Total bill was $36. How many glasses did each of them drink?

牛郎

$3

STOP PRESS

$6

x y

$x + 6y = 36$

織女

They ate potato crisps with their drink.
The total bill $36 included its cost $6!

牛郎	織女
~~0~~	~~6~~
~~2~~	~~5~~

牛郎	織女
~~8~~	~~2~~
~~10~~	~~1~~

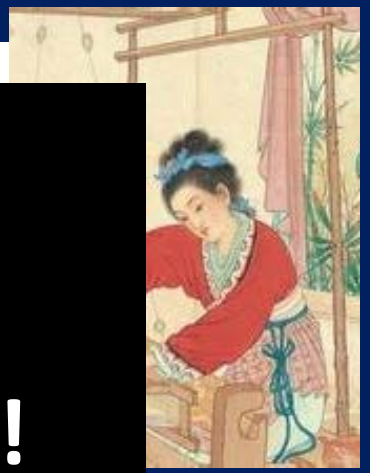
Start the process all over again !

Likely solutions
but still uncertain

牛郎

LESSON:

Examine the problem first !



織女

Geophysics

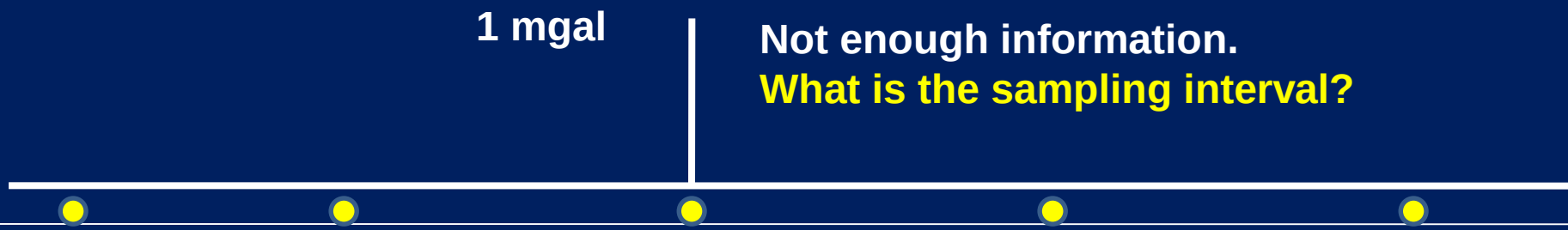
We measured gravity and processed data, and found the value of one point was 1 milligal higher than the surroundings.

What is under the ground and how deep?

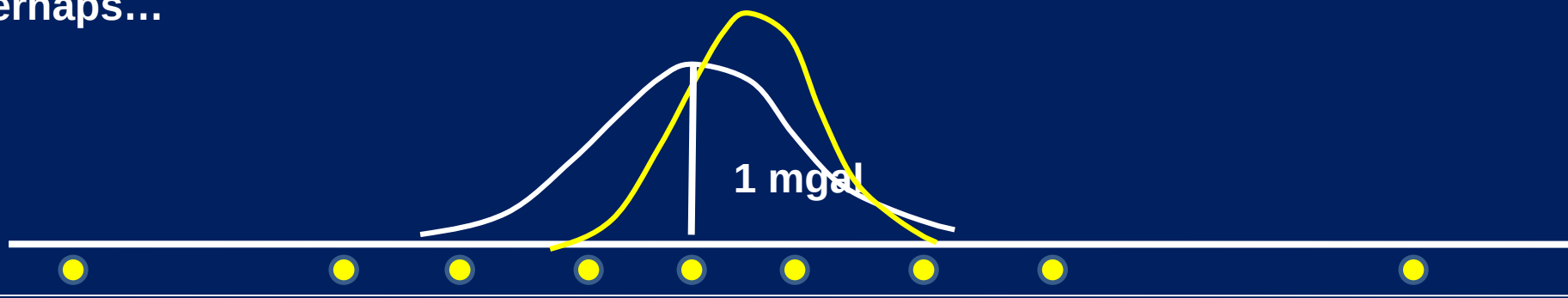
Geophysics

We measured gravity and processed data, and found the value of one point was 1 milligal higher than the surroundings.

What is under the ground and how deep?



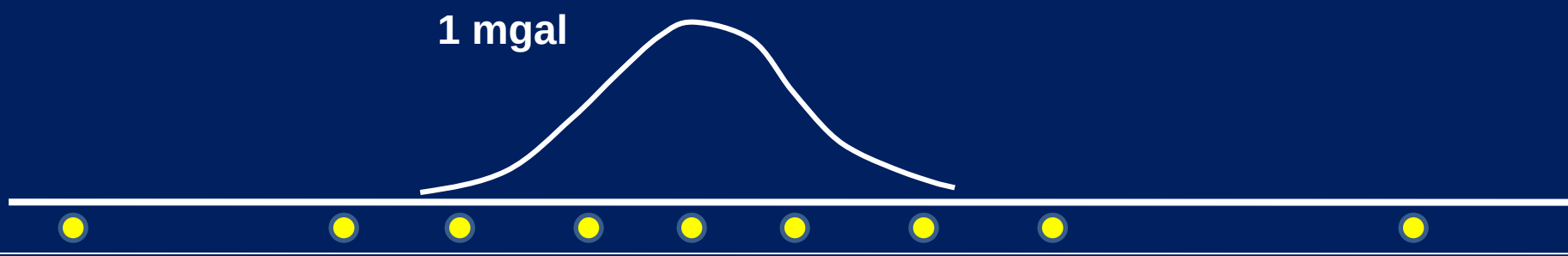
Because it is gravity, it is unlikely to be a singular point like this.
Perhaps…



Was the instrument OK? Measurement OK? Check it !

We measured gravity and processed data, and found the value of one point was 1 milligal higher than the surroundings.

What is under the ground and how deep?



Physics: Gravitational theory

$$f = G\frac{m_1 m_2}{r^2}$$

Gravitational acceleration caused by mass m_1 is:

$$a = G\frac{m_1}{r^2}$$

Physics

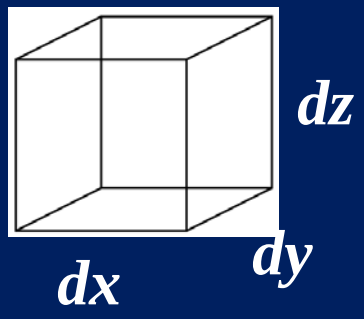
$$a = G\frac{m_1}{r^2}$$

Nice simple formula in idealised world.

Mass m_1 is concentrated at one point !

Real world: there is a volume to hold the mass of material.
mass is a product of density and volume.

Density = ρ



Situated at (x,y,z)

In mathematical language:

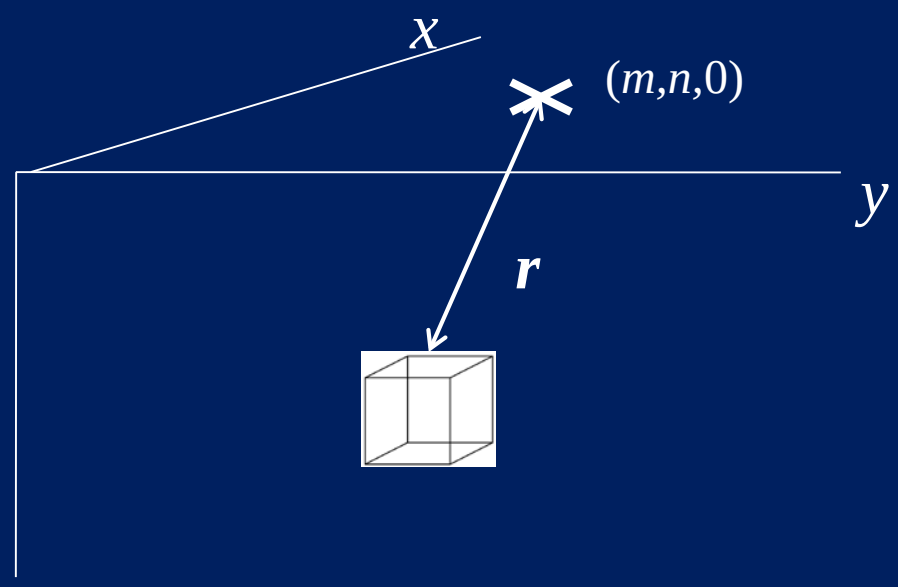
$$m_1 = \rho(x, y, z) \bullet dxdydz$$

Physics

$$a = G\frac{m_1}{r^2}$$

$$m_1 = \rho(x, y, z) \bullet dxdydz$$

$$a = G\frac{\rho(x, y, z) \bullet dxdydz}{r^2}$$

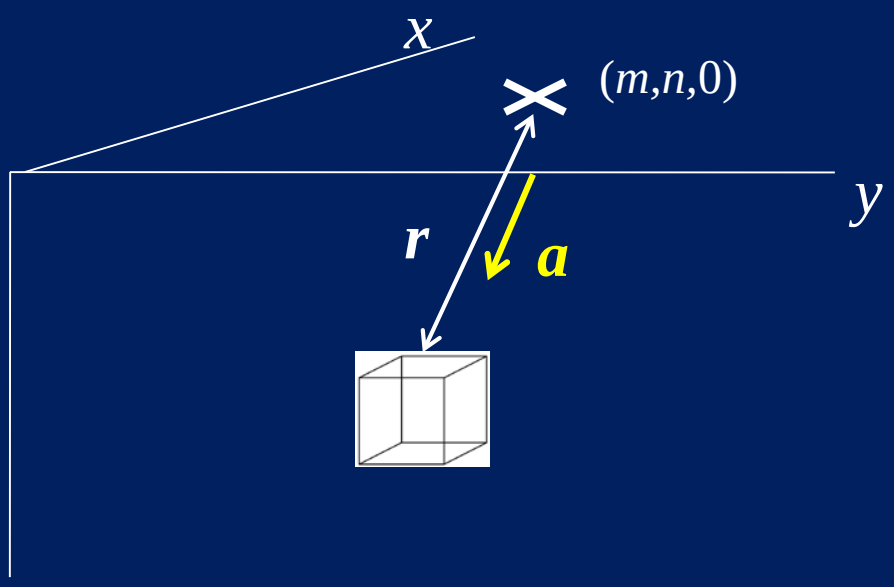


$$r = \sqrt{(x-m)^2 + (y-n)^2 + z^2}$$

$$a = G\frac{\rho(x,y,z)\bullet dxdydz}{r^2}$$

$$r = \sqrt{(x-m)^2 + (y-n)^2 + z^2}$$

$$\therefore \quad a = G\frac{\rho(x,y,z)\bullet dxdydz}{(x-m)^2 + (y-n)^2 + z^2}$$



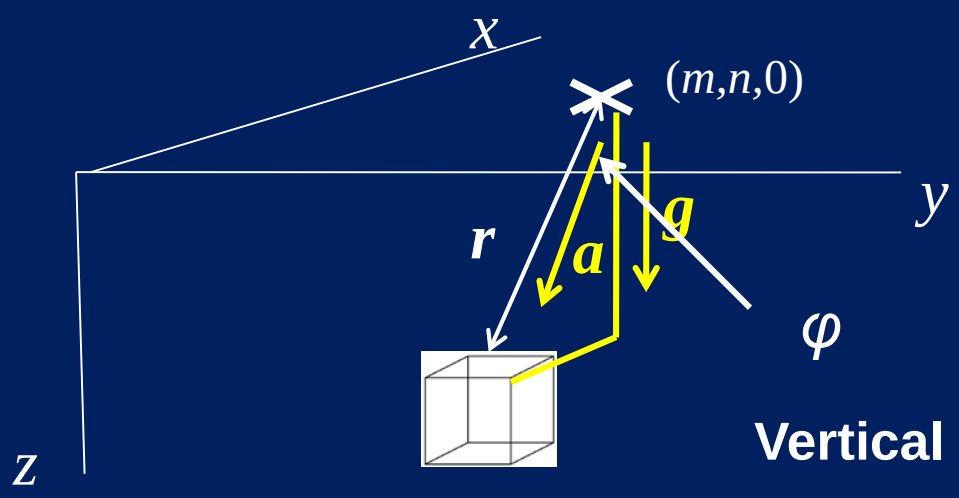
Total attraction towards the body

$$a = G\frac{\rho(x,y,z)\bullet dxdydz}{(x-m)^2+(y-n)^2+z^2}$$

Gravity is a measurement of the vertical component of the total attraction.

Multiply:

$$\cos\varphi = \frac{z}{\sqrt{(x-m)^2+(y-n)^2}}$$

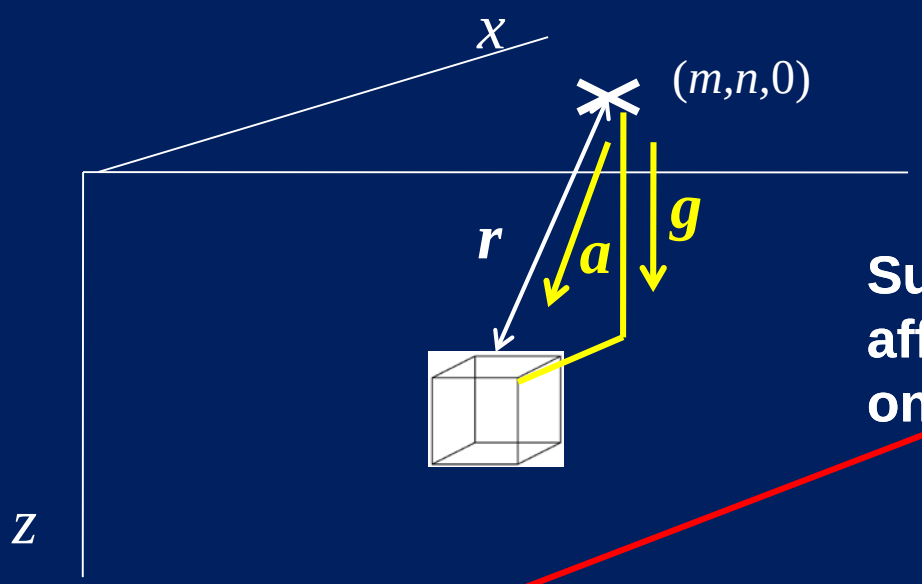


Vertical attraction by one little cube is:

$$g(m,n,0) = a\cos\varphi$$

$$= G\frac{\rho(x,y,z)dxdydz}{(x-m)^2+(y-n)^2+z^2}\cdot\frac{z}{\sqrt{(x-m)^2+(y-n)^2}}$$

$$g(m,n,0) = G\frac{\rho(x,y,z)dxdydz}{(x-m)^2+(y-n)^2+z^2}\cdot\frac{z}{\sqrt{(x-m)^2+(y-n)^2}}$$

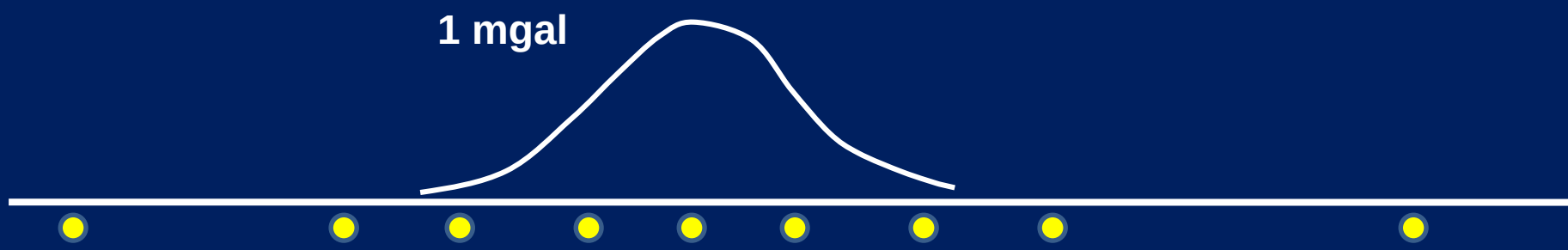


Such cubes in the entire universe affect the gravitational attraction at one point *(m,n,0)*.

$$g(m,n,0) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} G\frac{\rho(x,y,z)}{(x-m)^2+(y-n)^2+z^2}\cdot\frac{z}{\sqrt{(x-m)^2+(y-n)^2}}dxdydz$$

We measured gravity and processed data, and found the value of one point was 1 milligal higher than the surroundings.

What is under the ground and how deep?



Now it is written in mathematical language: **Beautiful, symmetrical!**

$$g(m,n,0)=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} G\frac{\rho(x,y,z)}{(x-m)^2+(y-n)^2+z^2}\cdot\frac{z}{\sqrt{(x-m)^2+(y-n)^2}}dxdydz$$

Our Problem $g(m,n,0)=1mgal$

What is $\rho(x,y,z)$?

$$g(m,n,0)=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} G\frac{\rho(x,y,z)}{(x-m)^2+(y-n)^2+z^2}\cdot\frac{z}{\sqrt{(x-m)^2+(y-n)^2}}dxdydz$$

In reality: **Physical measurement is subject to errors**

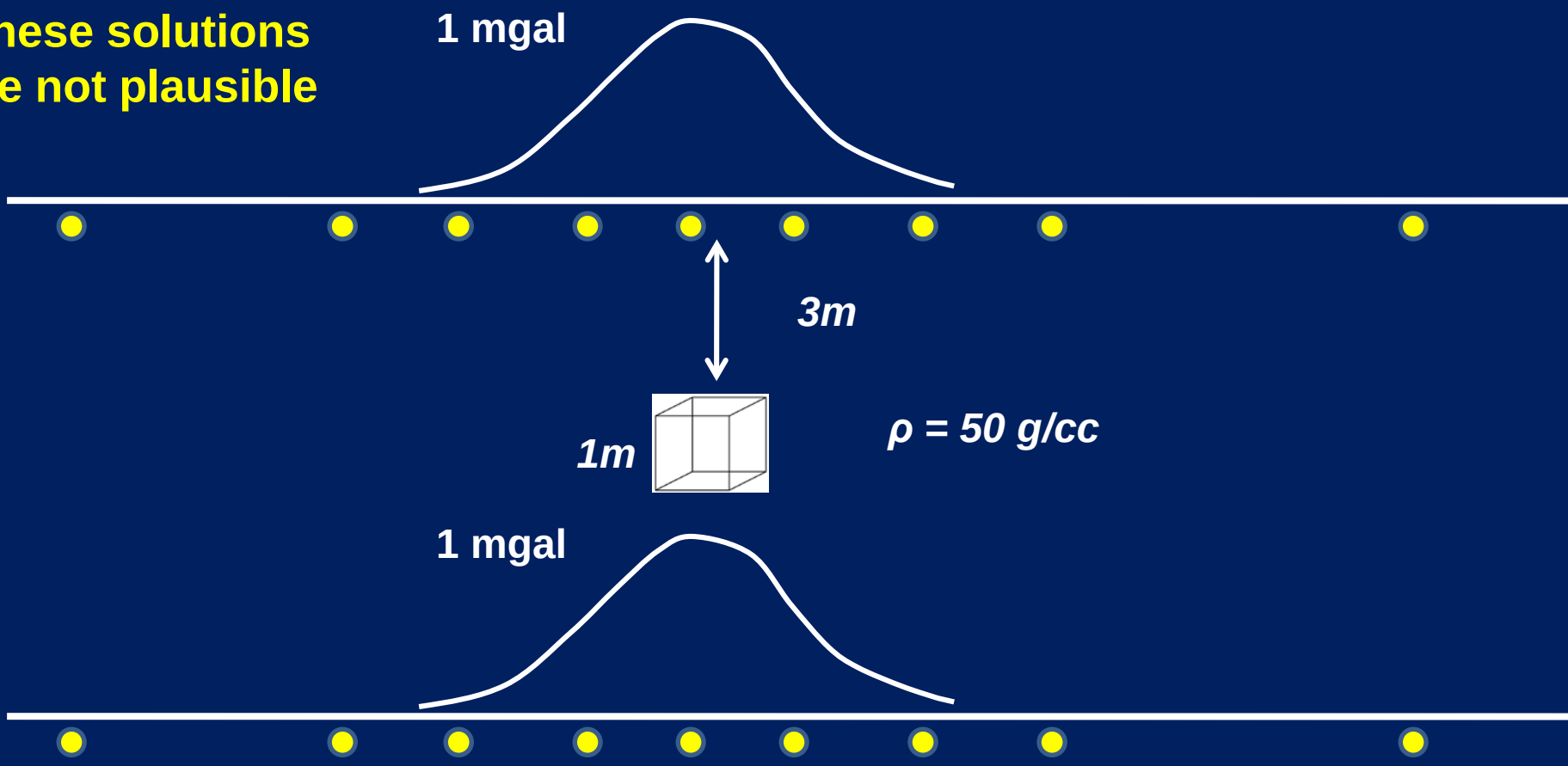
Instrumental errors	Some are specific to location
Ambient errors (Noise)	Some are time variant
Operator errors	Some are random
Unknown noise	**Overall it is unpredictable**

$$g(m,n,0)=\int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} G\frac{\rho(x,y,z)}{(x-m)^2+(y-n)^2+z^2}\cdot\frac{z}{\sqrt{(x-m)^2+(y-n)^2}}dxdydz$$
$$+Ei(m,n,0,t)+Ea(m,n,0,t)+Eo(m,n,0,t)+Eu(m,n,0,t)$$
$$=1(mgal)$$

Don’t worry nobody asks you to solve this.

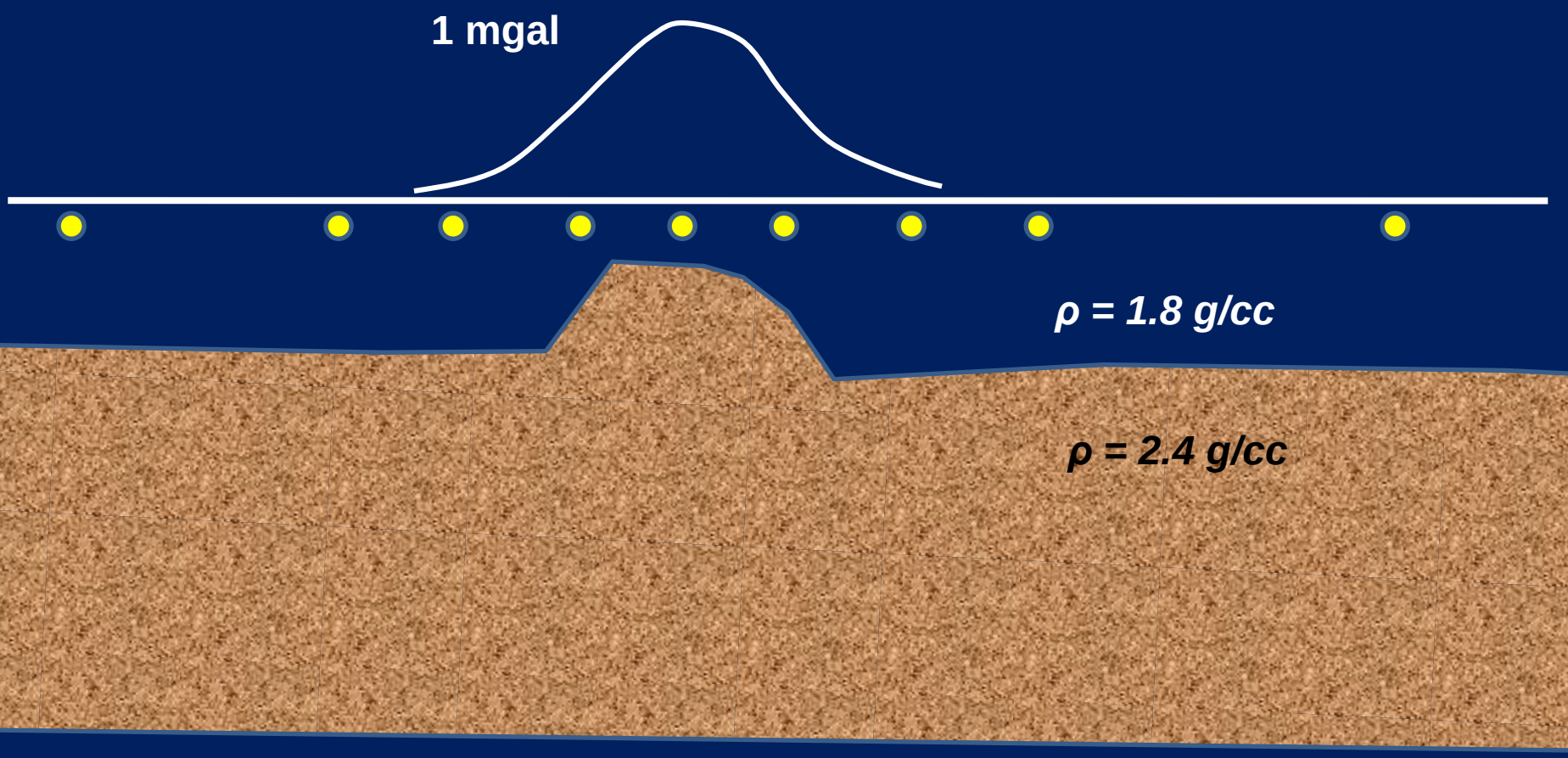
We have computers.

These solutions are not plausible

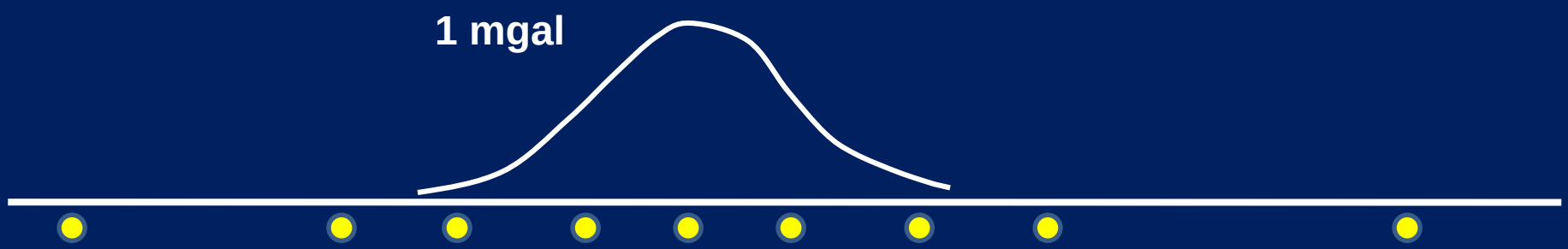


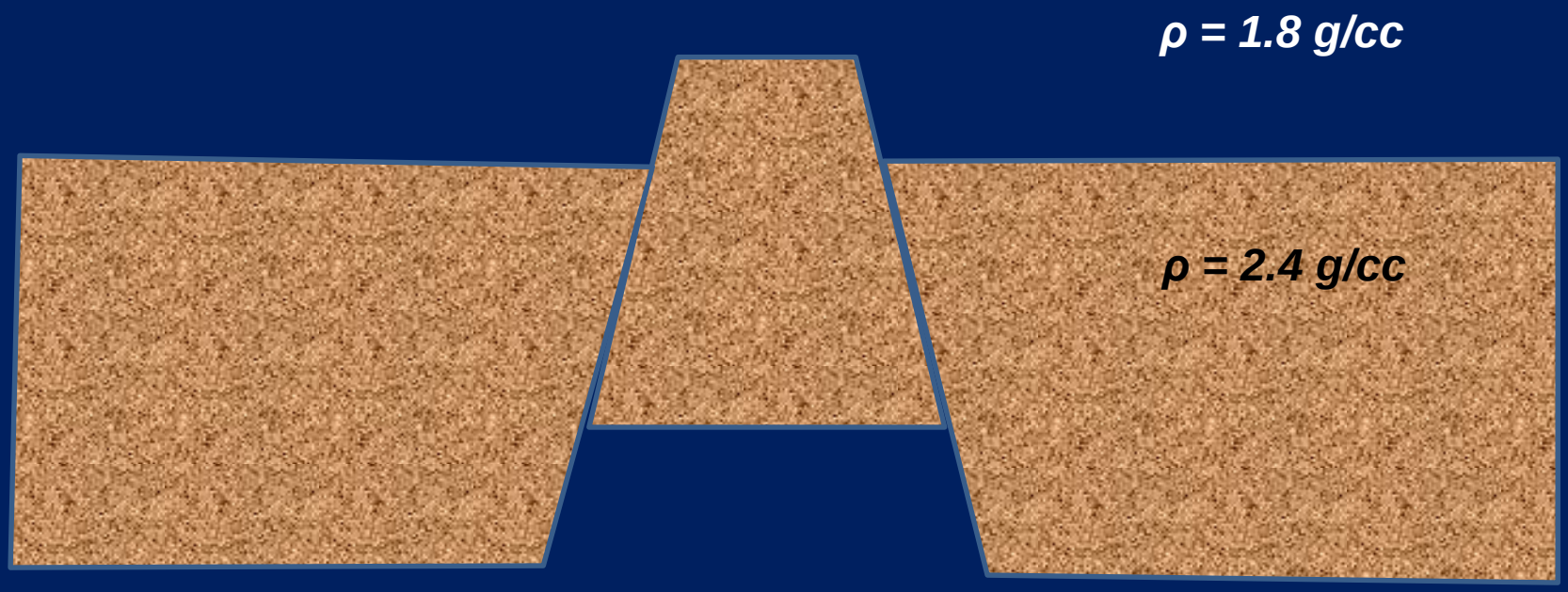
Buried Channel

This solution is more plausible



These solution is even more plausible (Horst model)





$$g(m,n,0) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} G\frac{\rho(x,y,z)}{(x-m)^2+(y-n)^2+z^2}\cdot\frac{z}{\sqrt{(x-m)^2+(y-n)^2}}dxdydz$$
$$+ Ei(m,n,0,t) + Ea(m,n,0,t) + Eo(m,n,0,t) + Eu(m,n,0,t)$$
$$= 1(mgal)$$

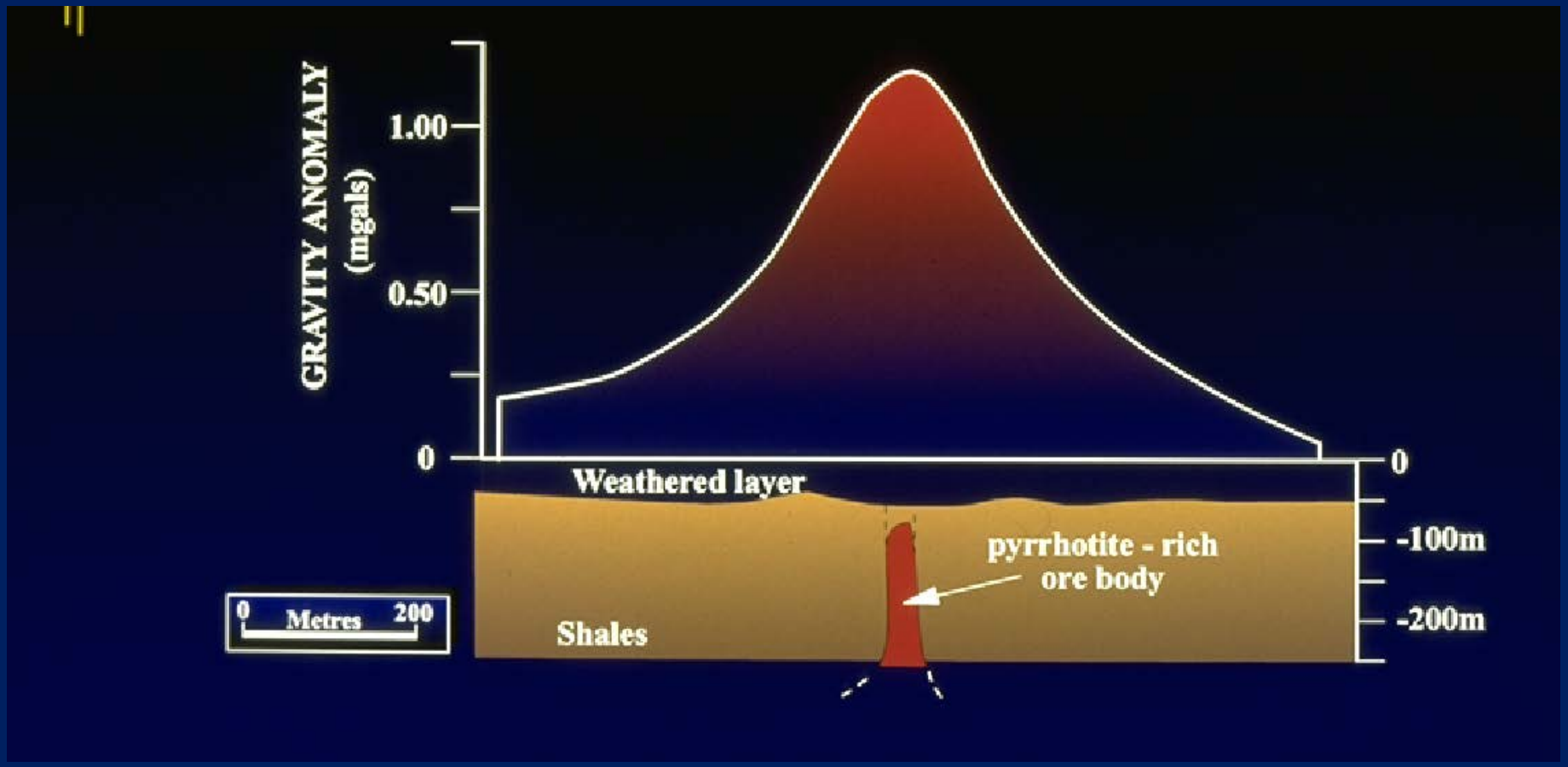
What we saw:

- No need to integrate to infinity. Effect from a distant material is negligible.

What do we know to constrain the model ?

- Gravity is a potential field
- Density may be within a certain range.
- Geological reality.

One of many solutions and it hit an ore body !

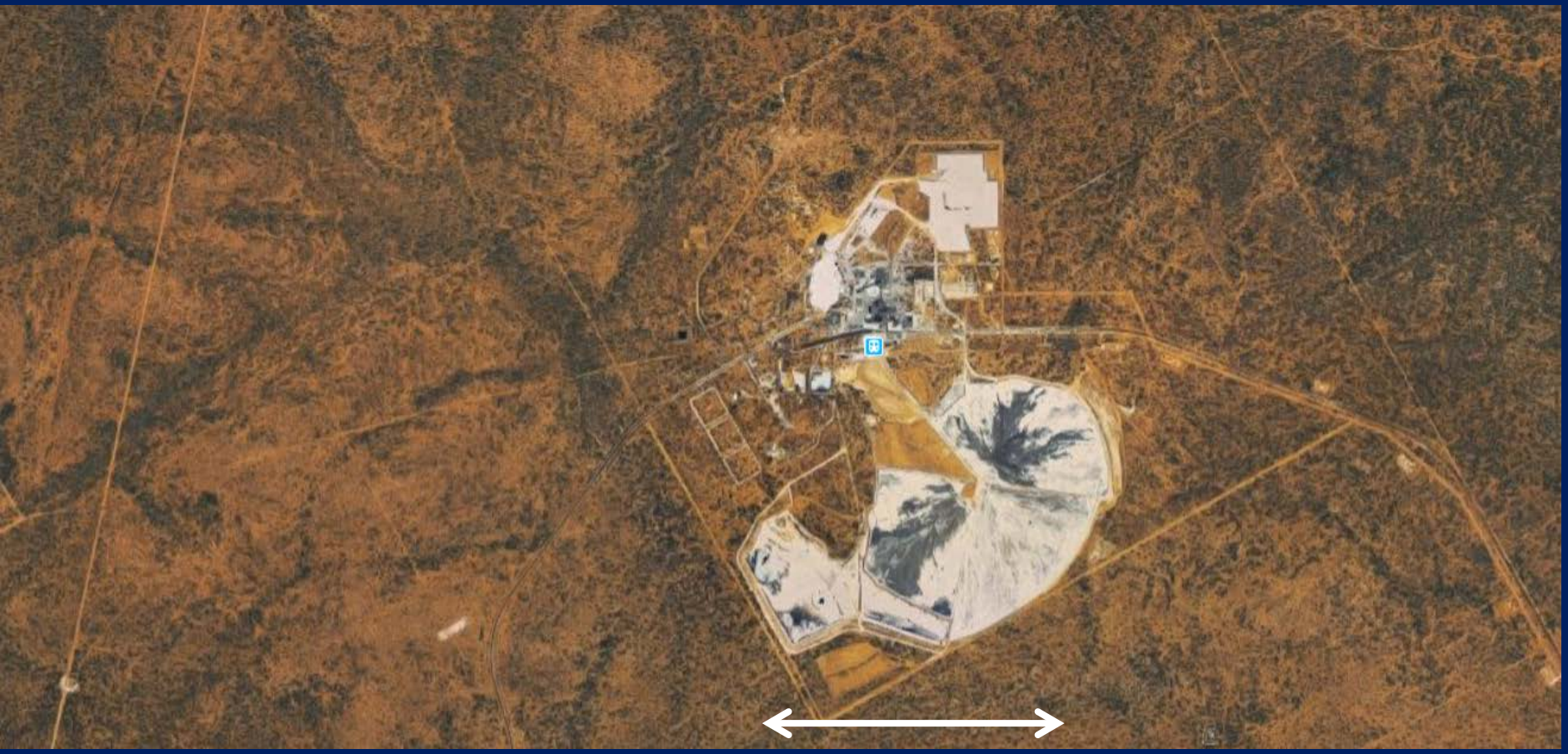


Elura Ore Body

Whitbread (2002)

Elura Orebody. (Silver-Lead-Zonc) Discovered in 1974.

Elura Ore Body



The deposit contained a total pre-mining resource of 45 Mt at 8.5% Zn, 5.3% Pb and 69 g/t Ag. (David, 2008)

My Life as a Geophysicist

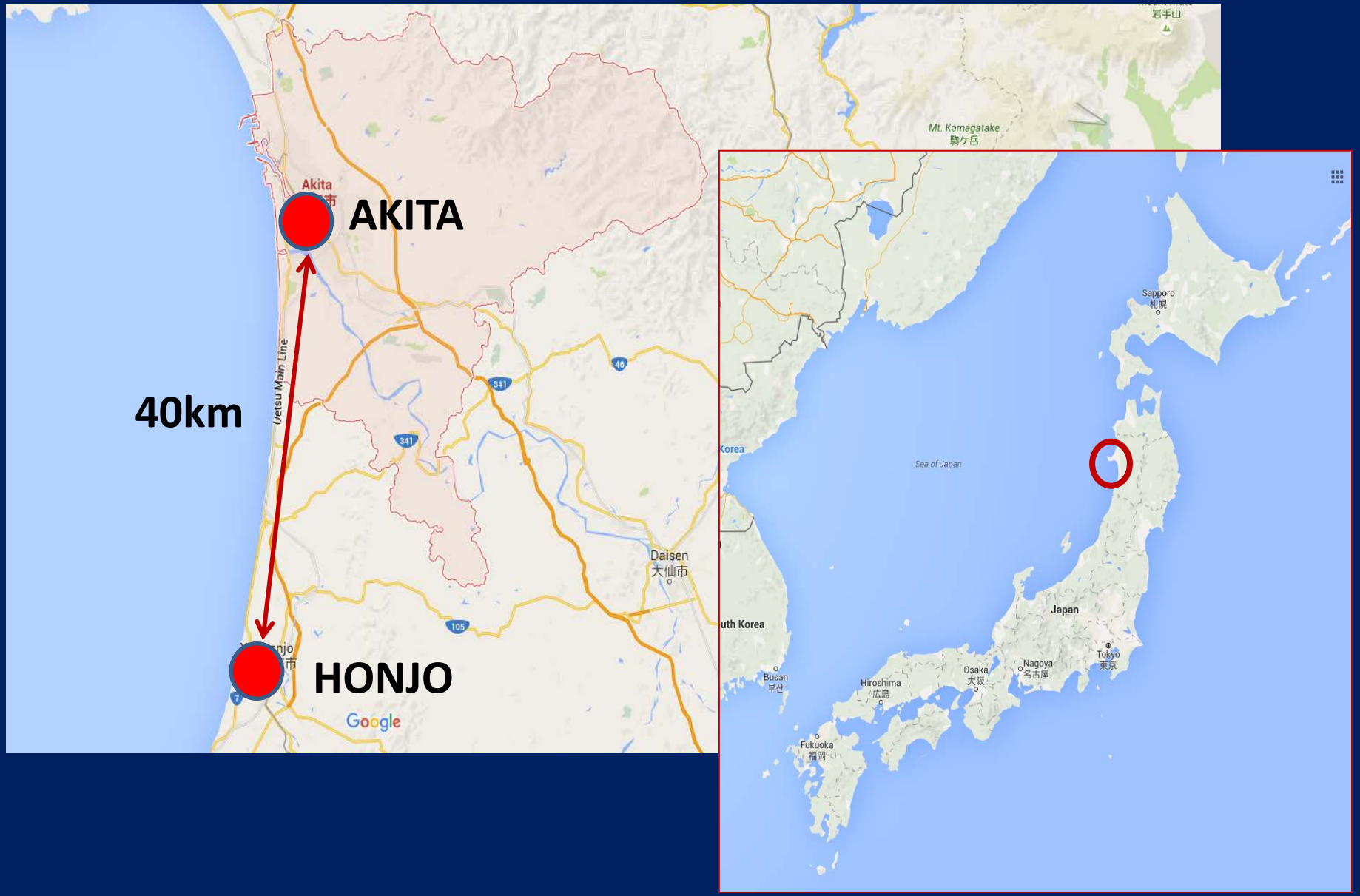
Koya Suto

Born in Japan

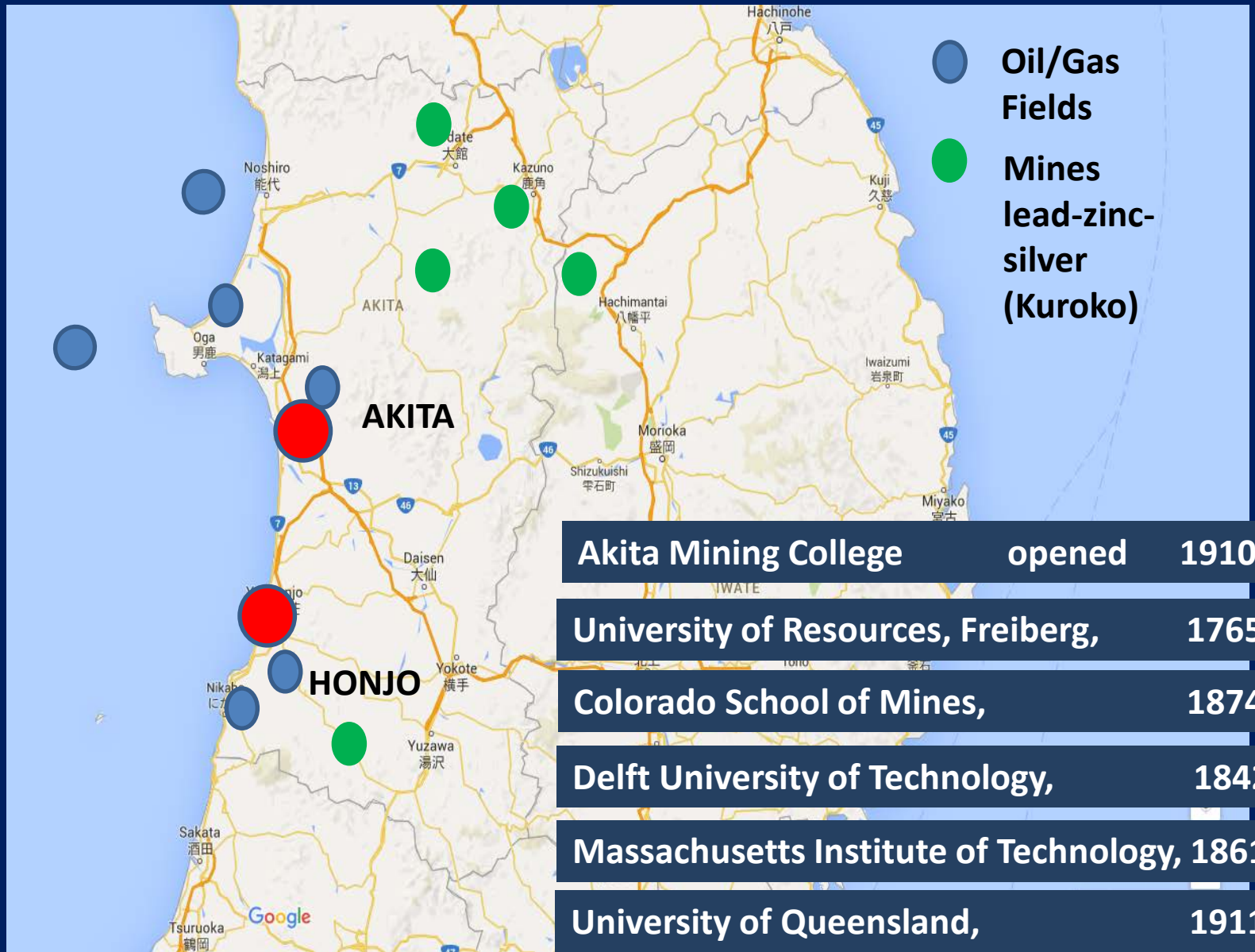
cs

I am not an academic

I was brought up in Honjo, and graduated from Akita University

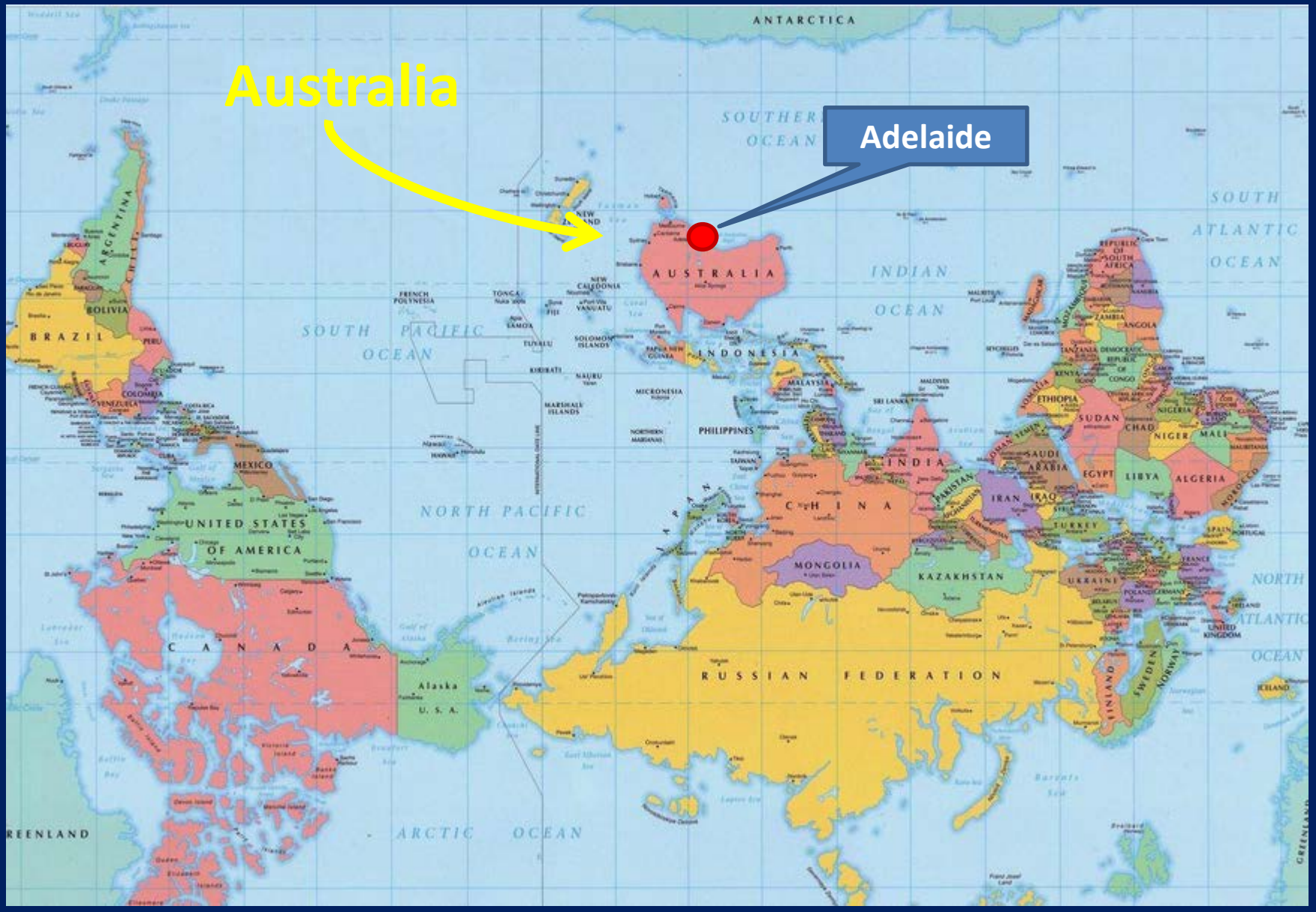


I was brought up in Honjo, and graduated Akita University



Akita Mining College	opened	1910.
University of Resources, Freiberg,		1765.
Colorado School of Mines,		1874.
Delft University of Technology,		1842.
Massachusetts Institute of Technology,		1861.
University of Queensland,		1911.

Moved to Adelaide, Australia 1975



Travelling Around

Skill in geophysics is transferable.

Small Scale - to 100m Engineering Geophysics

Within the region of common human activity

Is the ground firm enough to support these structures?

Near-Surface Geophysics (Engineering Geophysics):

Geophysics within the region of common human activity

Some keywords

- Construction - Infrastructure
- Improving wellbeing – Life style
- Secure and safe living
- Convenience

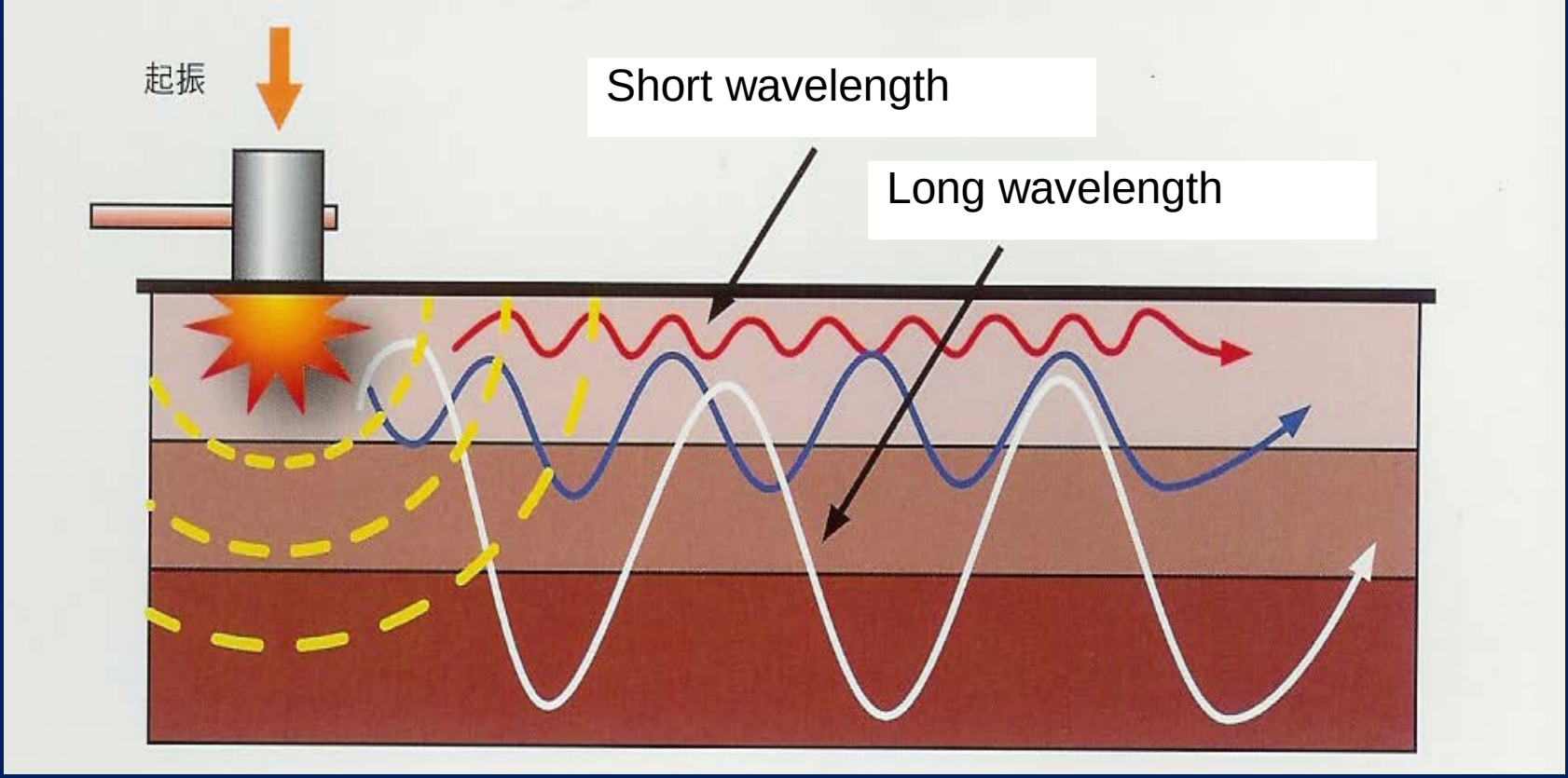
We are the geophysicists most visible to the human community.

Questions

- Is the ground firm enough to support these structures?
- Is the ground soft enough to excavate? (Do we need explosives?)
- Is this structure safe?
  - How does it react to earthquakes?
  - Where are safe places to build?
- Where is water, and how much?

The Multichannel Analysis of Surface Wave (MASW) Method

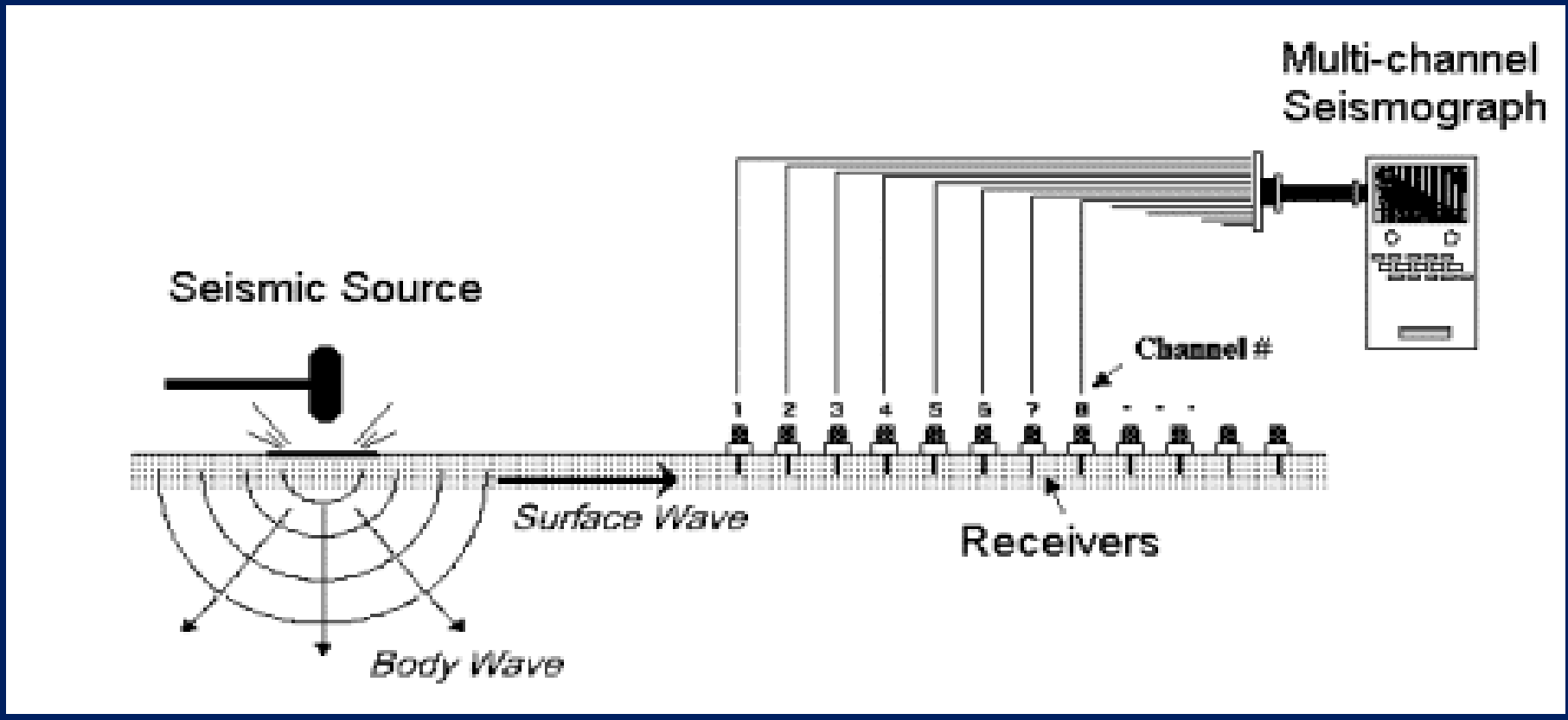
Surface Wave Survey Methods



Conceptual diagram of surface wave propagation
From OYO brochure

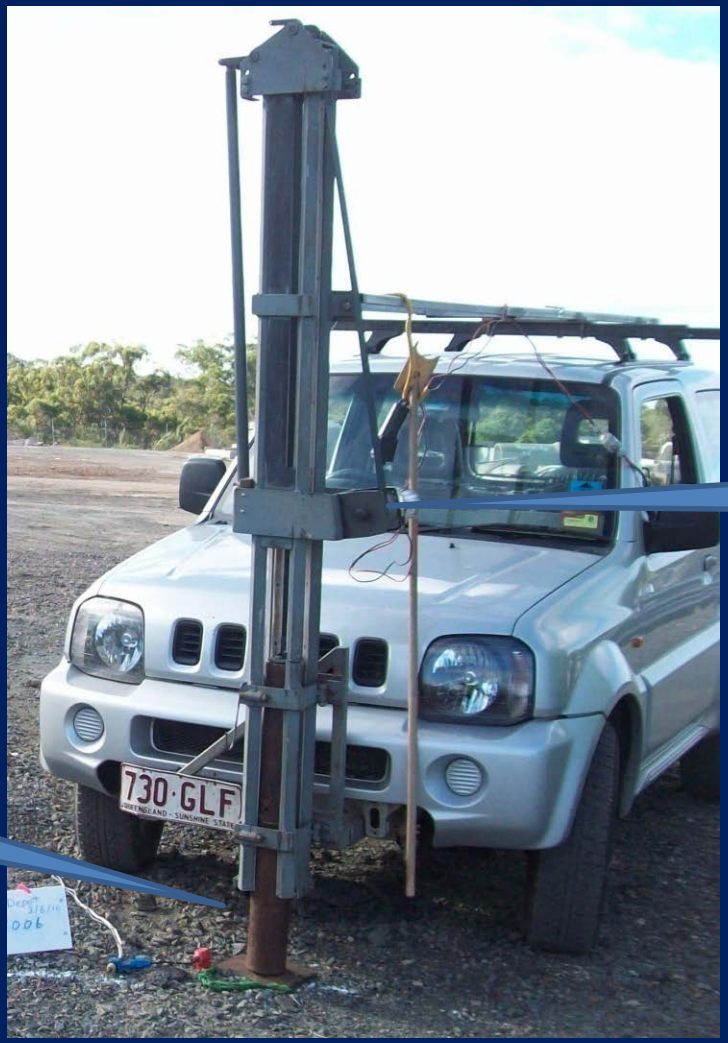
Short-wavelength components attenuate quickly with depth

The MASW Method



From Kansas Geological Survey website

Field Procedure Seismic Source - Ours



12V Winch

Weight 50kg

Suto (2011)

MASW Field Procedure

Laying Cable and Connecting Geophones

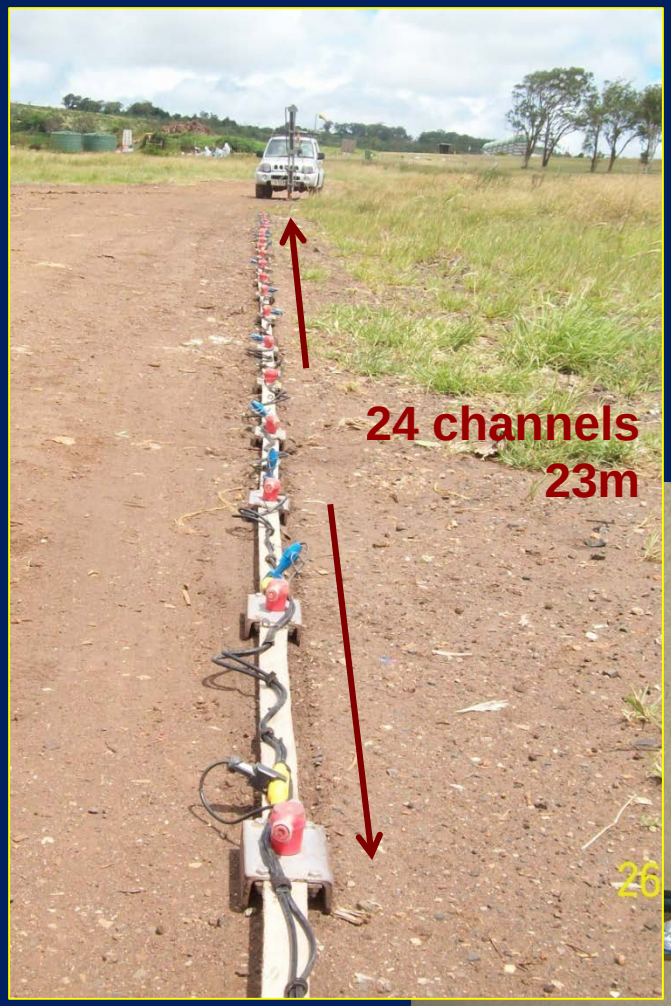
Laying Cable and Connecting Geophones

Laying Cable and Connecting Geophones

Sometimes, setting up is a hard work

Geophone

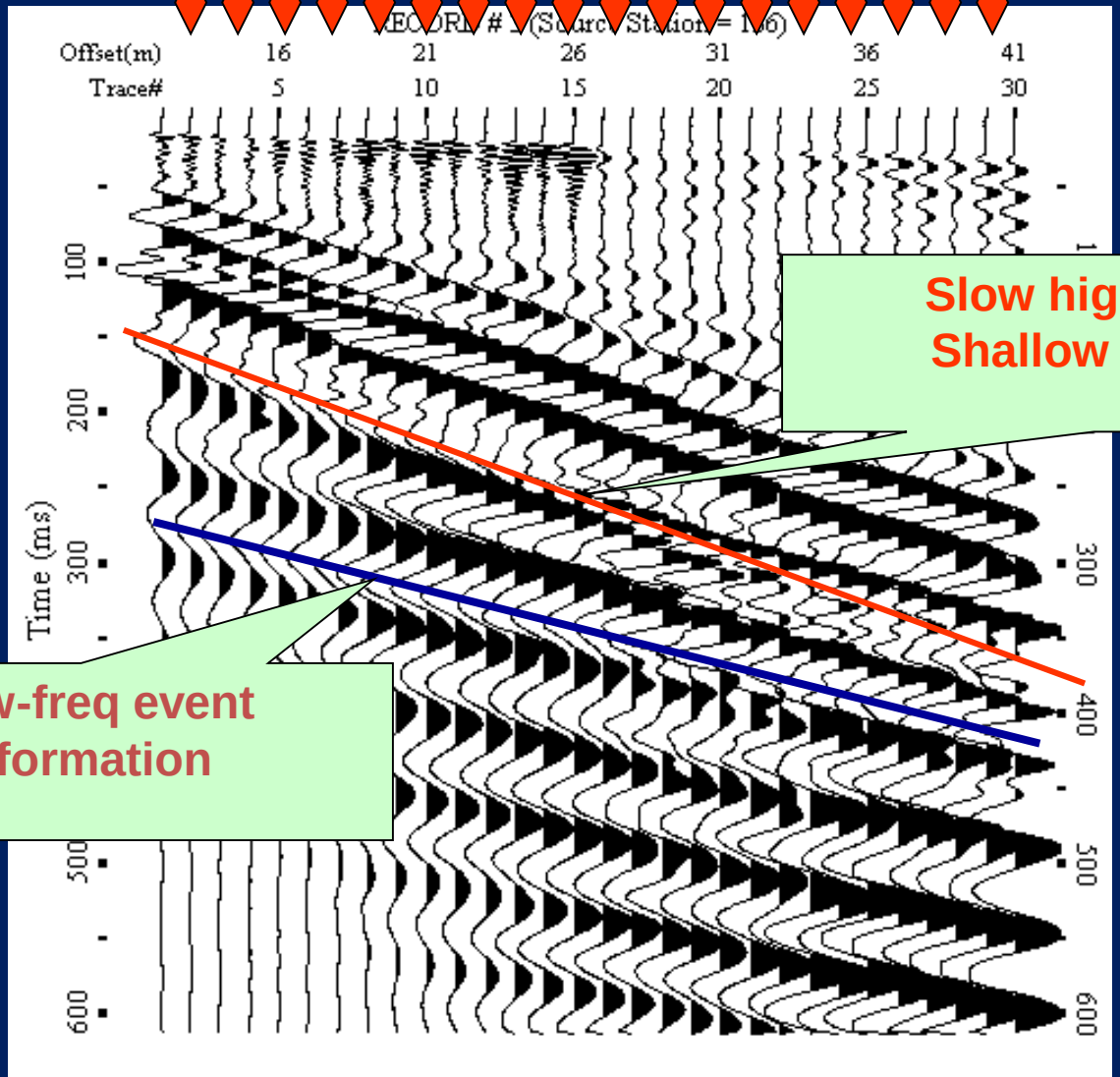
Field Procedure Using Land Streamer



Using a Landstreamer

The Seismic Methods
(MASW Method – Sample Data)

Geophones



Slow high-freq event
Shallow information

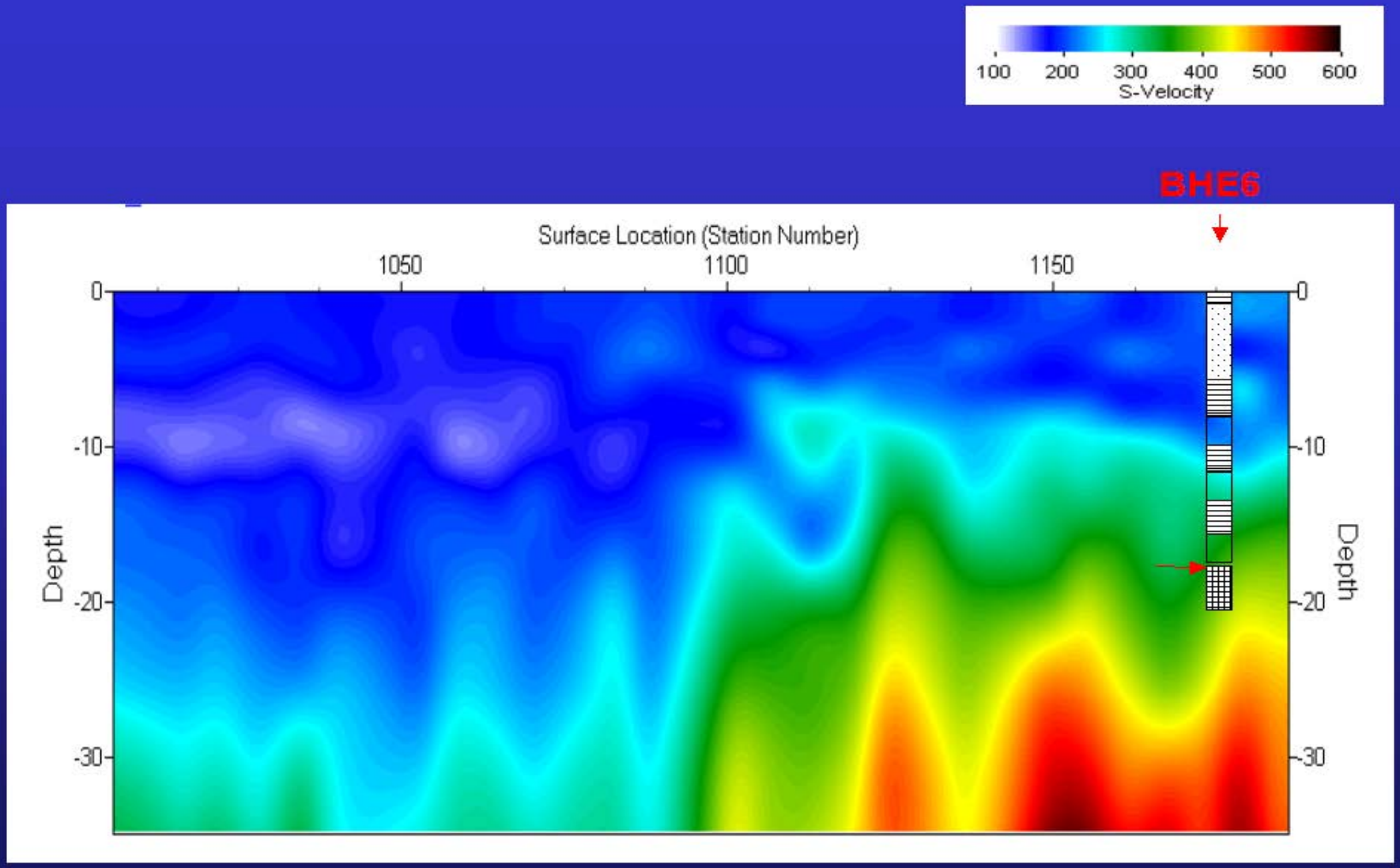
Faster low-freq event
Deep information

T

Vs Section

Along a road

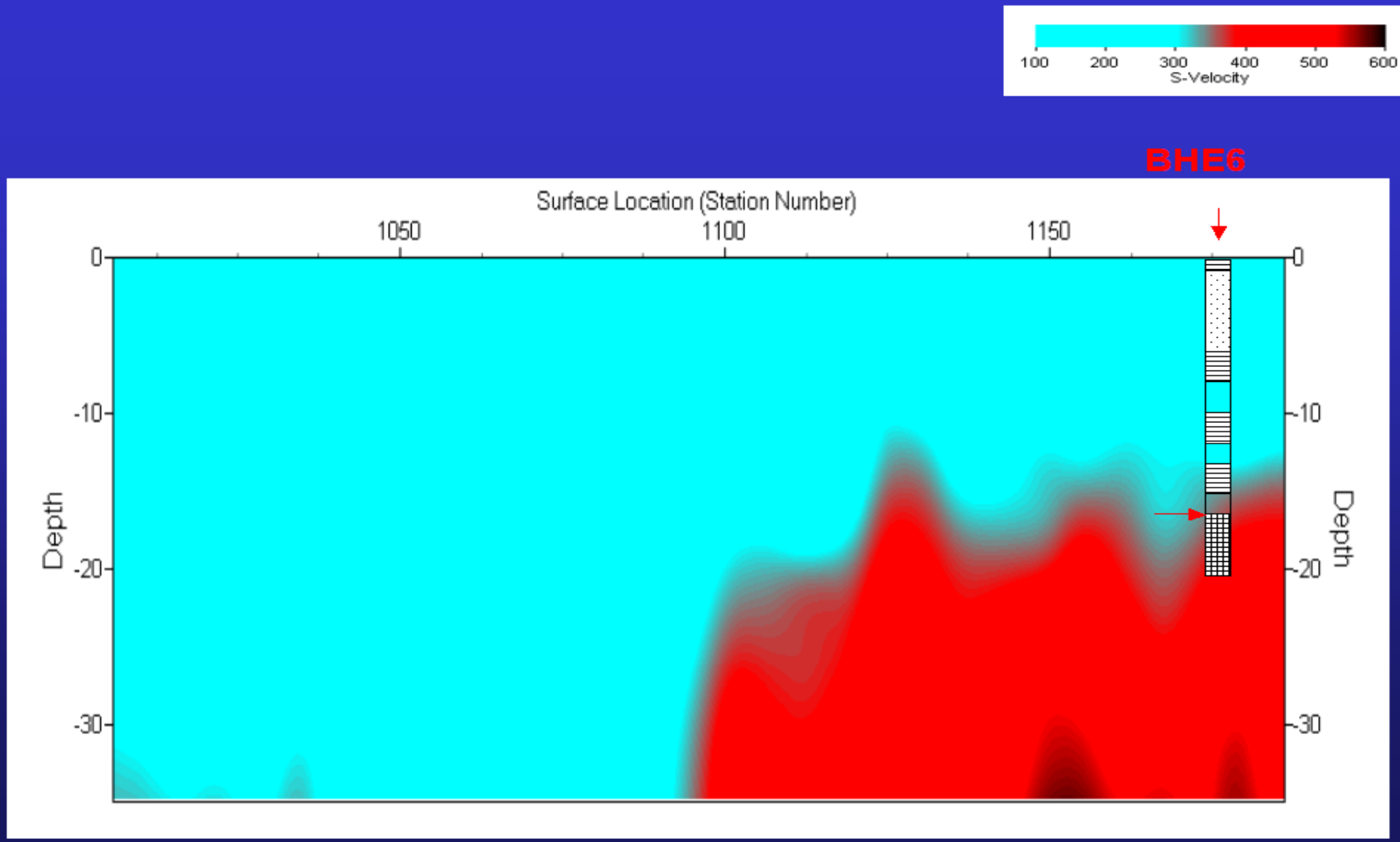
Survey for bedrock depth



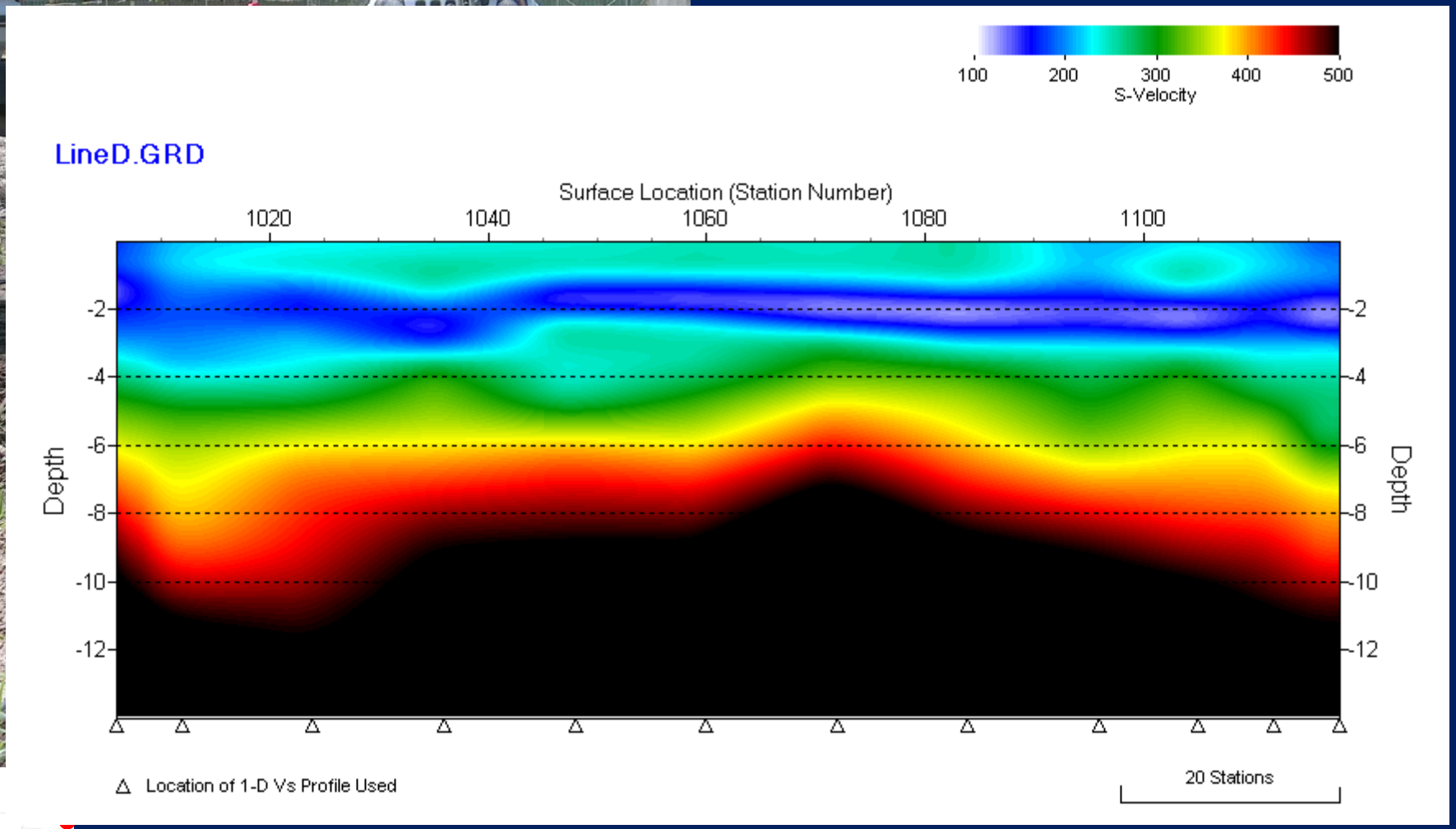
Calibration

Along a road

Survey for bedrock depth



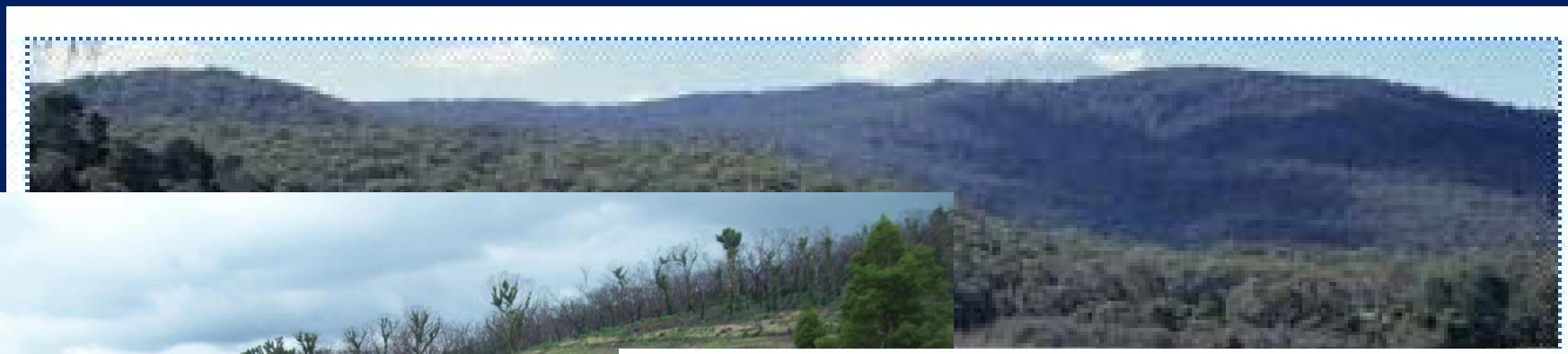
Example- Construction site – Compaction monitor

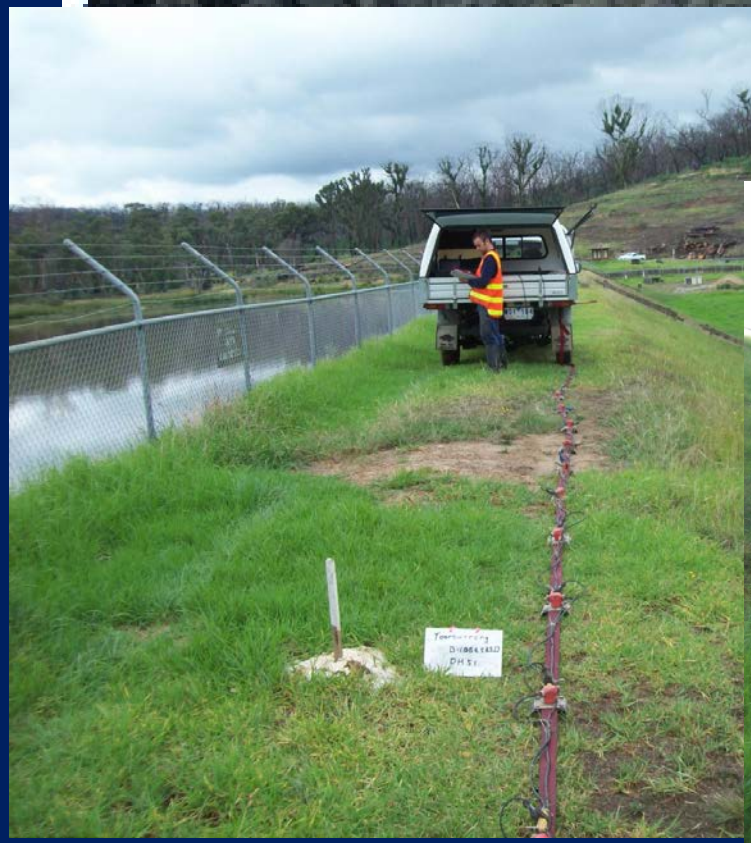


Example - Old fill site for re-development

MASW
Data Acquisition

Example – Hydrological Investigation - Leak of a Dam





Example – Road widening

Example – Railway

Case

Site Assessment for Planned Hydroelectric Dam

Site Assessment for Planned Hydroelectric Dam

Solomon Islands

Site Assessment for Planned Hydroelectric Dam

Solomon Islands

http://www.flysolomons.com/

Site Assessment for Planned Hydroelectric Dam

Honiara - Capital City

http://www.oocities.org/
https://upload.wikimedia.org

Site Assessment for Planned Hydroelectric Dam

Honiara Market

http://www.abmission.

Site Assessment for Planned Hydroelectric Dam

Solomon Island - Village

http://www.theabk.com.au/

Site Assessment for Planned Hydroelectric Dam

Solomon Island - Economy

IMF2018

	Solomon Islands	Rank		Comparison	
GDP	US$1,440M	171		US	US$21,439,453M
GDP per capita	US$2,242	167		Qatar	US$130,475 (1)
				Taiwan	US$53,023 (14)

Price of Electricity (US cents per kWH)

Wikipedia

Solomon Is	88 - 99	1		Saudi Arabia	1 - 7
Vanuatu	60	2		Taiwan	5-16
				US	8 - 17
Japan	20 - 24			UK	22
Netherland	29			Australia	15-54

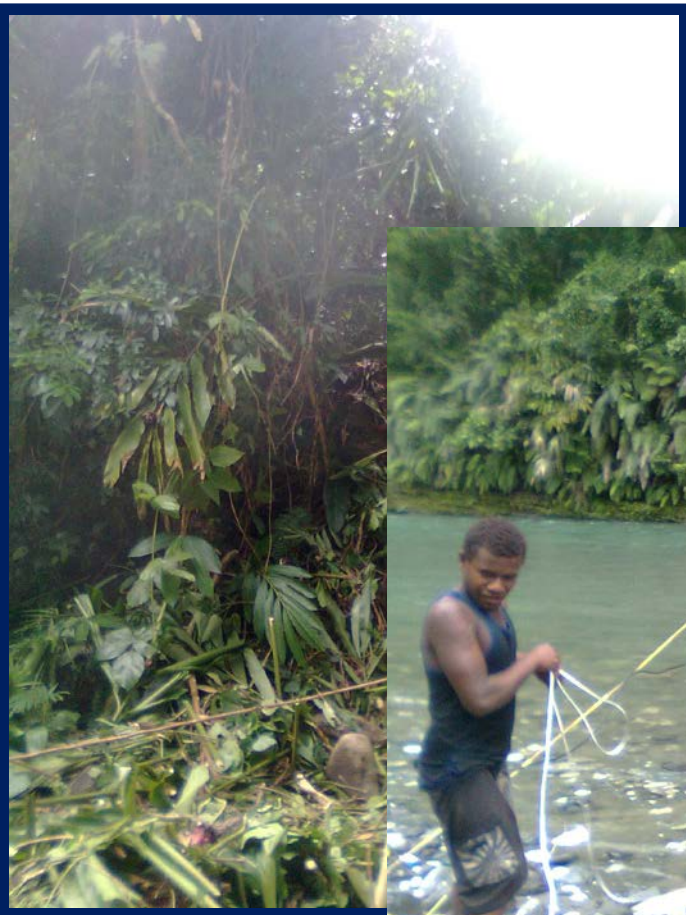
Site Assessment for Planned Hydroelectric Dam

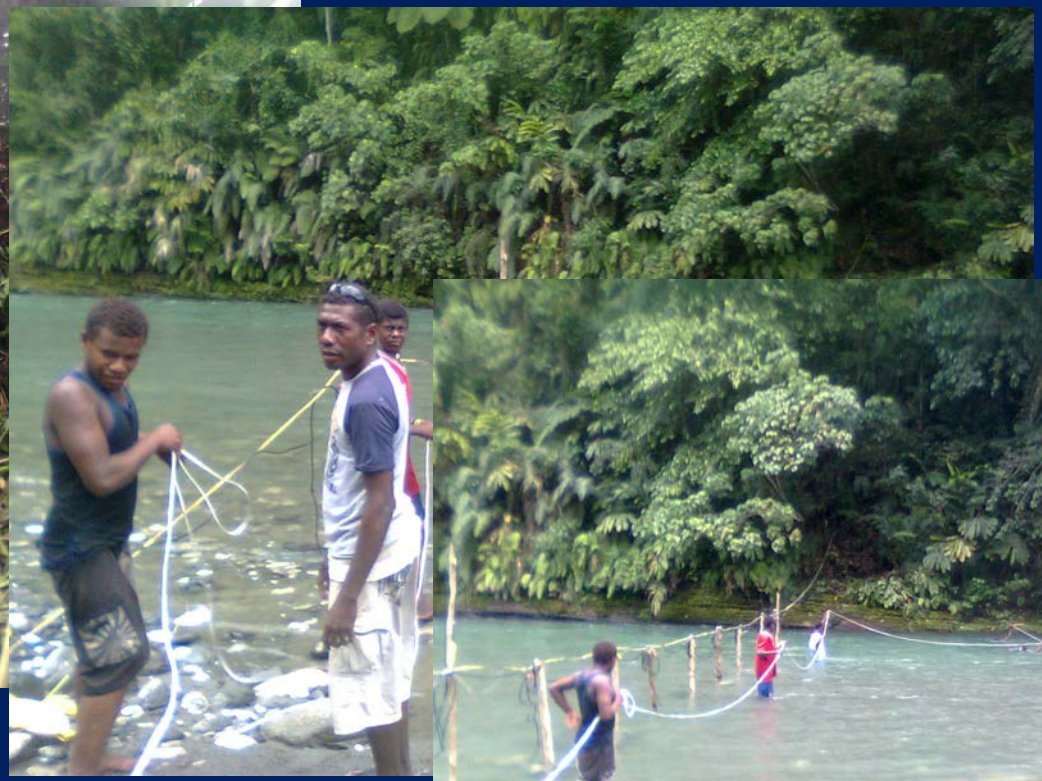
Tina River – Solomon Islands

Site Assessment for Planned Hydroelectric Dam

Tina River – Candidate location for a dam

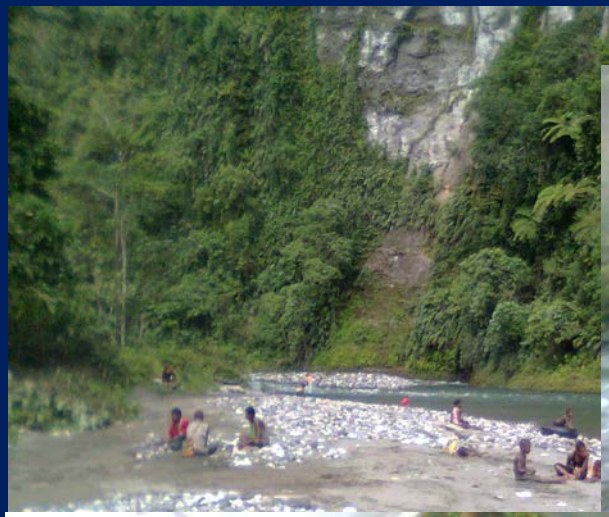
Site Assessment for Planned Hydroelectric Dam





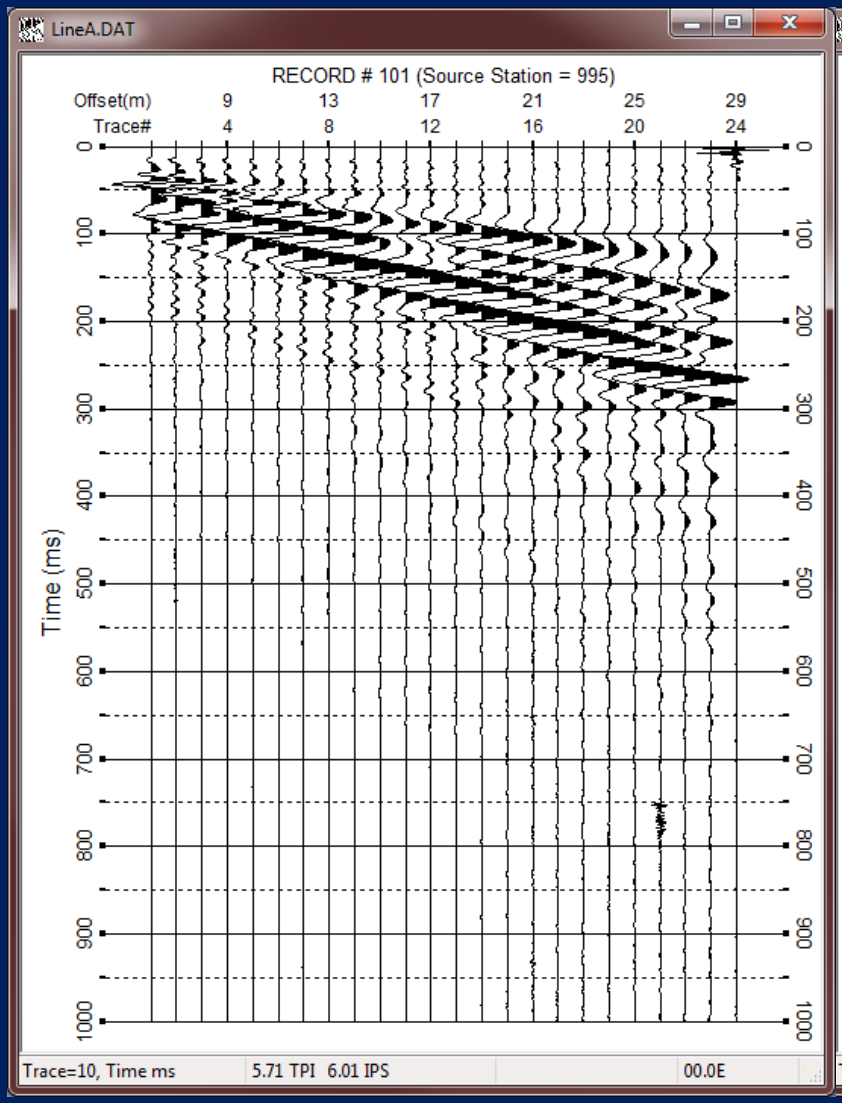
Site Assessment for Planned Hydroelectric Dam

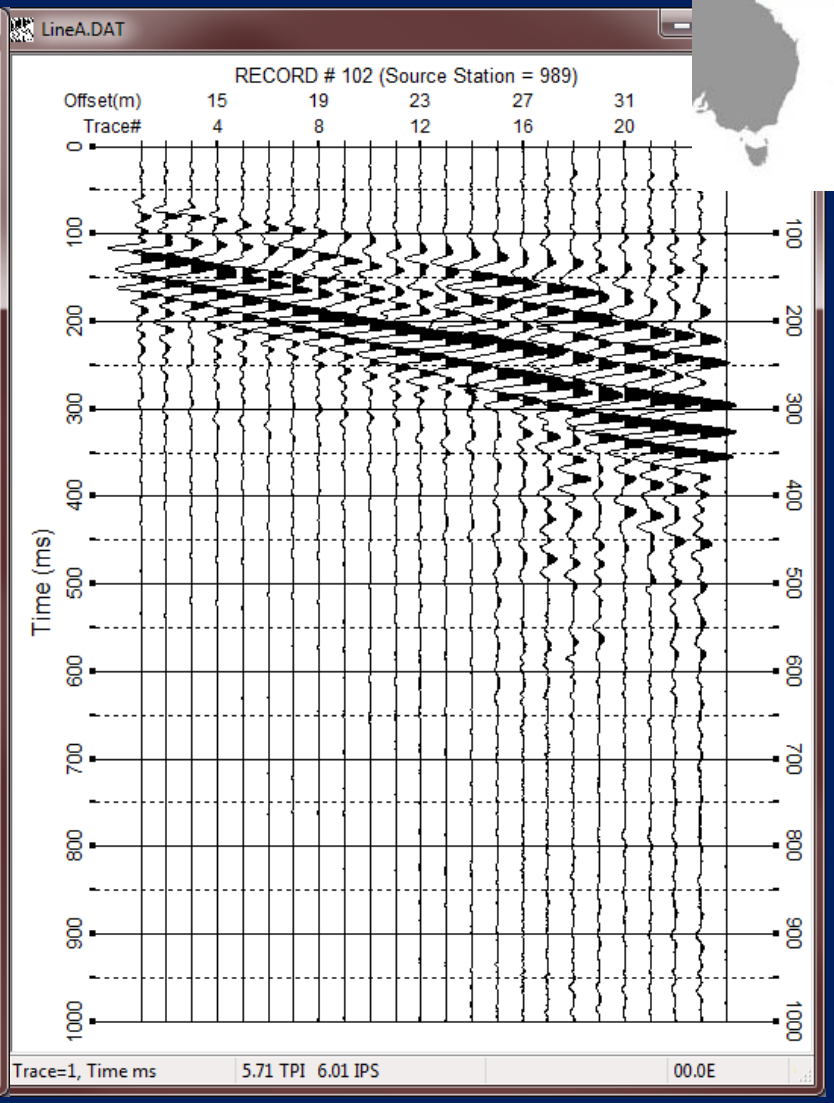
Site Assessment for Planned Hydroelectric Dam



Site Assessment for Planned Hydroelectric Dam

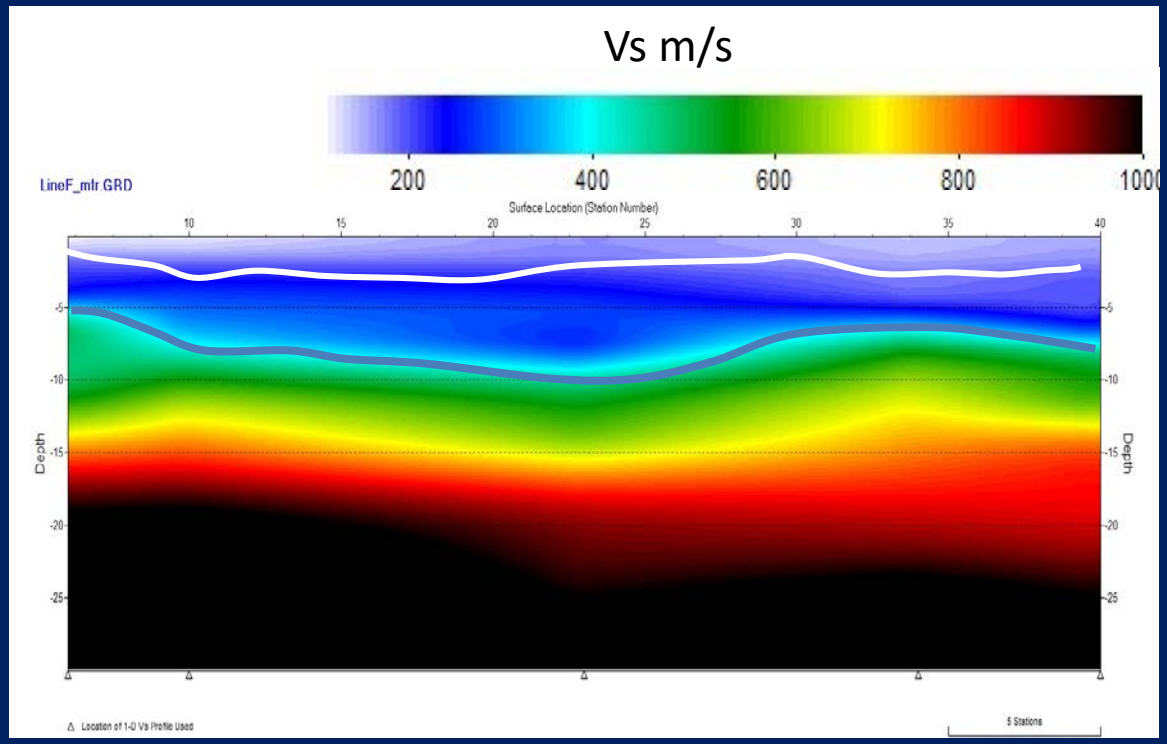
Line A across the river



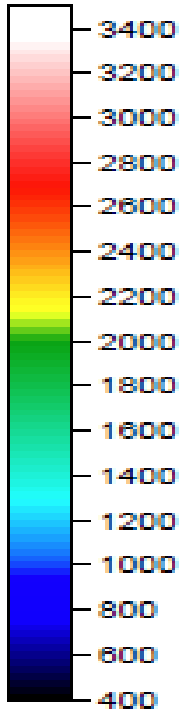


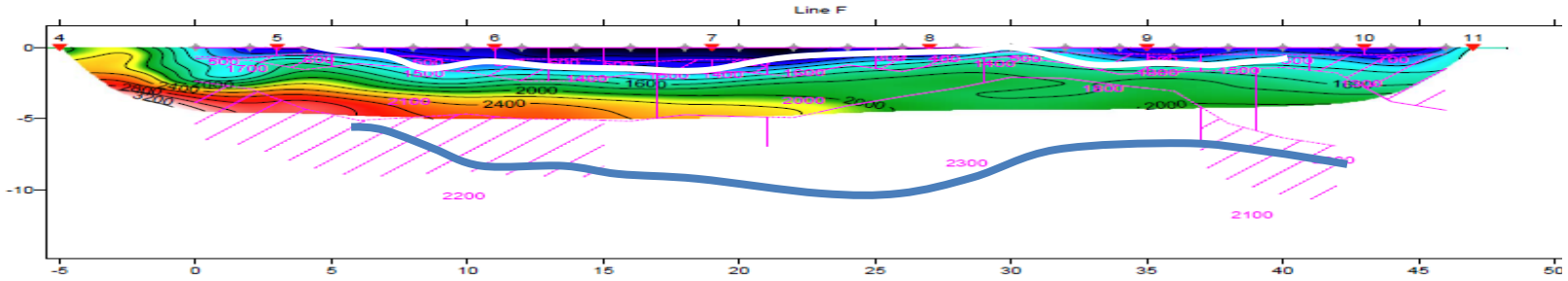
Site Assessment for Planned Hydroelectric Dam

Line F along the river



Vp m/s





Tina River Hydro Project

- Dam height: 35 – 50 m
- Capacity: 5 – 8 MW
  (Covers consumption of Honiara)
- Power line: 22km
- Contracted: Sept 2015
- Completion: Dec 2018

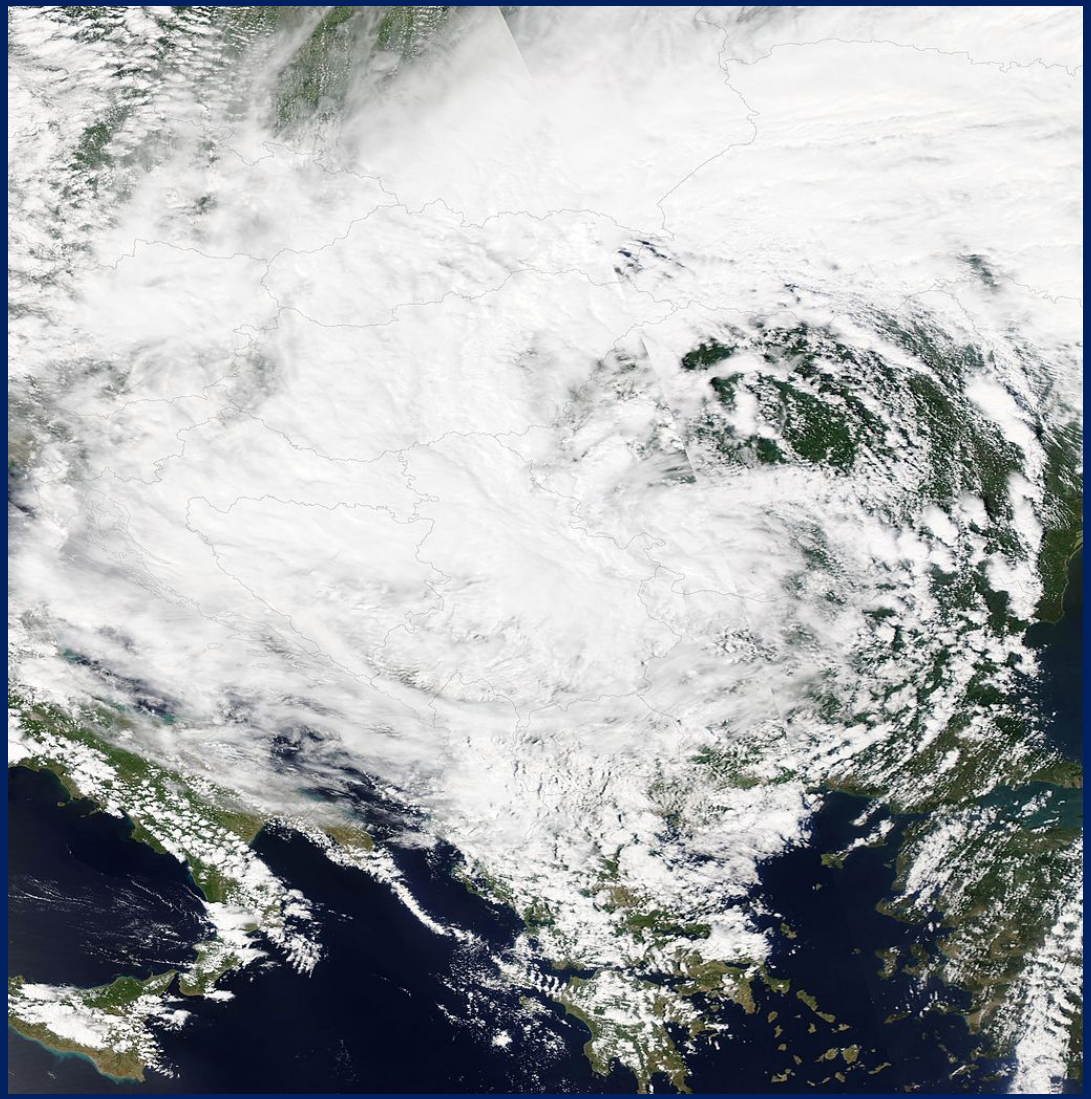
My Experience - In Balkan

Case

Sava Flood Damage Assessment Program Serbia and Bosnia & Herzegovina 2015-2017

(a Geoscientists *without* Borders project)

Satellite Image 15 May 2014



Heaviest rain in 120 years

62 People died (by 20 May)

1.6 million people affected

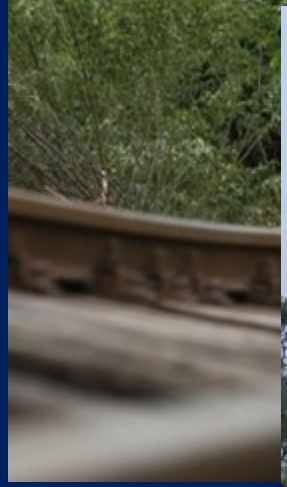
2000 Landslides

Damage in Serbia estimated
1.55 billion euro

Damage in Bosnia & Herzegovina
Exceeds that of Bosnian War

Many foreign countries and international bodies sent aid.

Disrupting Human Life



Damaging Infrastructure

Sava Flood Damage Assessment Program
Serbia and Bosnia & Herzegovina 2015

Scouting March 2015
Work Started June 2015

Practicing Geophysicists

Geophysical Surveys
To Assess Damages

Result

Practical Experience Training

Introducing Methods Training

Universities

Students

Understanding Support

Local Governments

Engineers

Local Community

Design:
Recovery
Disaster
Mitigation

Benefit

Pre-start Meeting

Geoscientists *without* Borders

Meeting with Local Governments

River Sava through Valjevo City

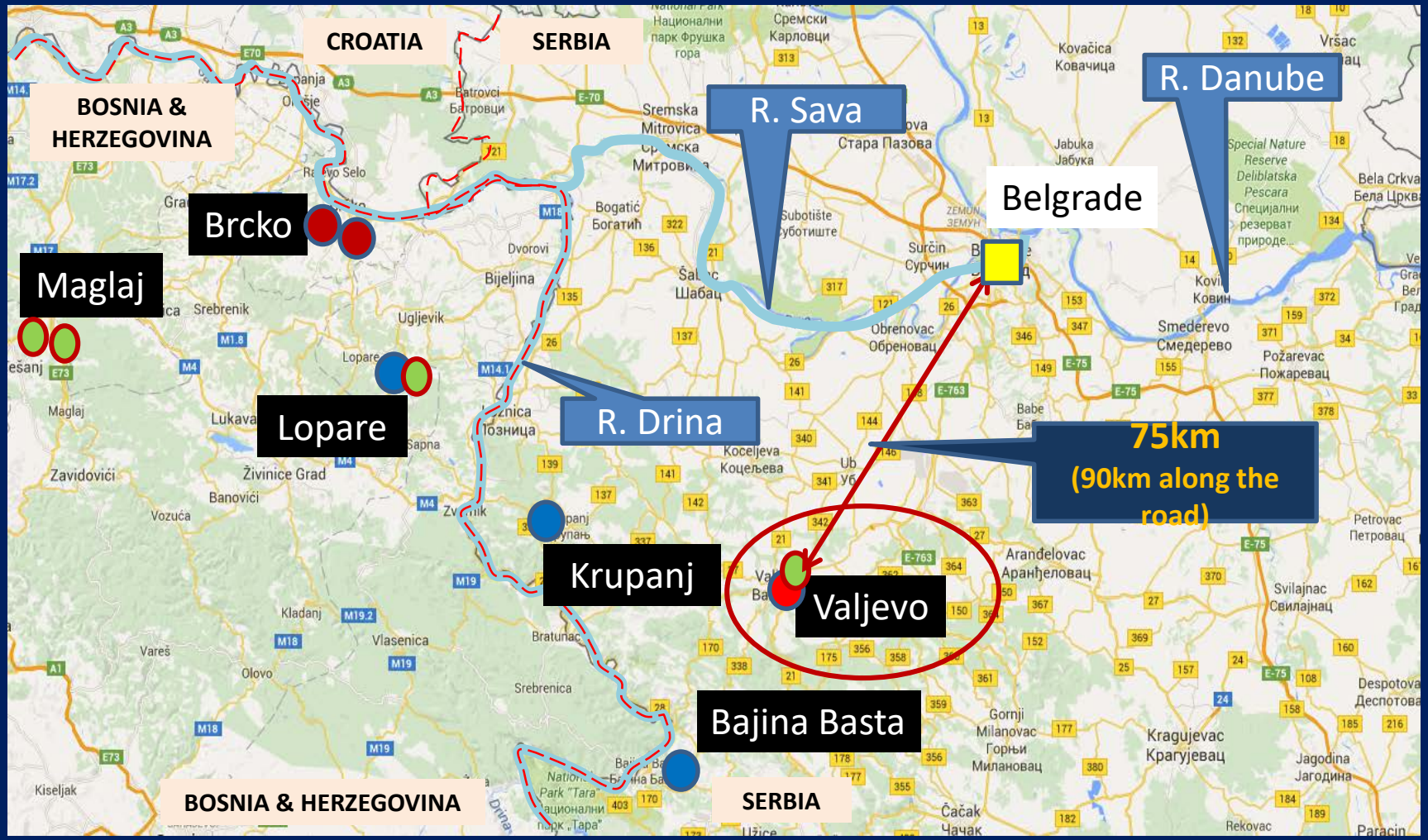
Geoscientists *without* Borders Damage to Residence

Project Locations

June 2015

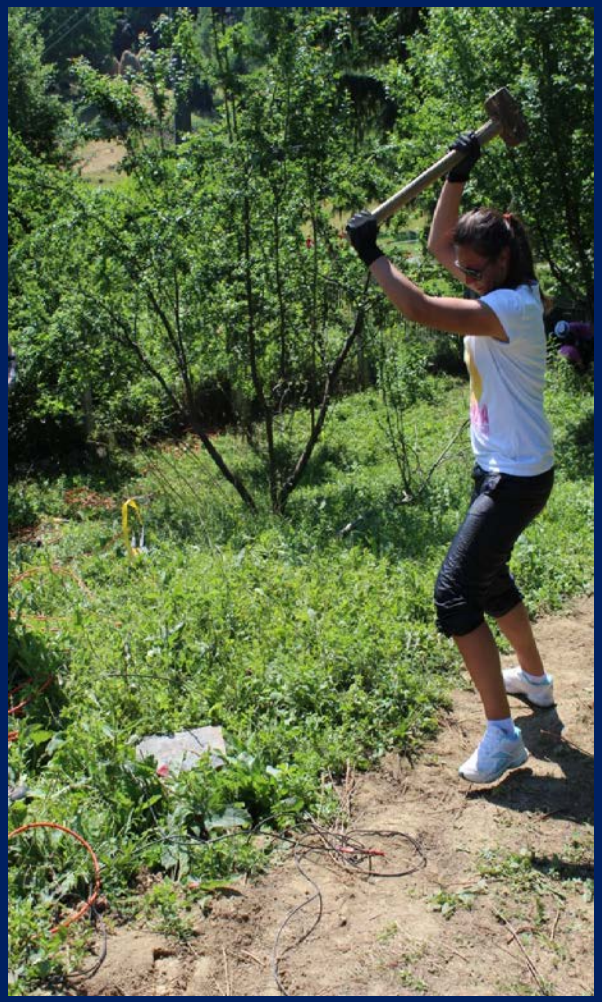
June 2016

September 2015



Geoscientists *without* Borders Field Data Acquisition Seismic

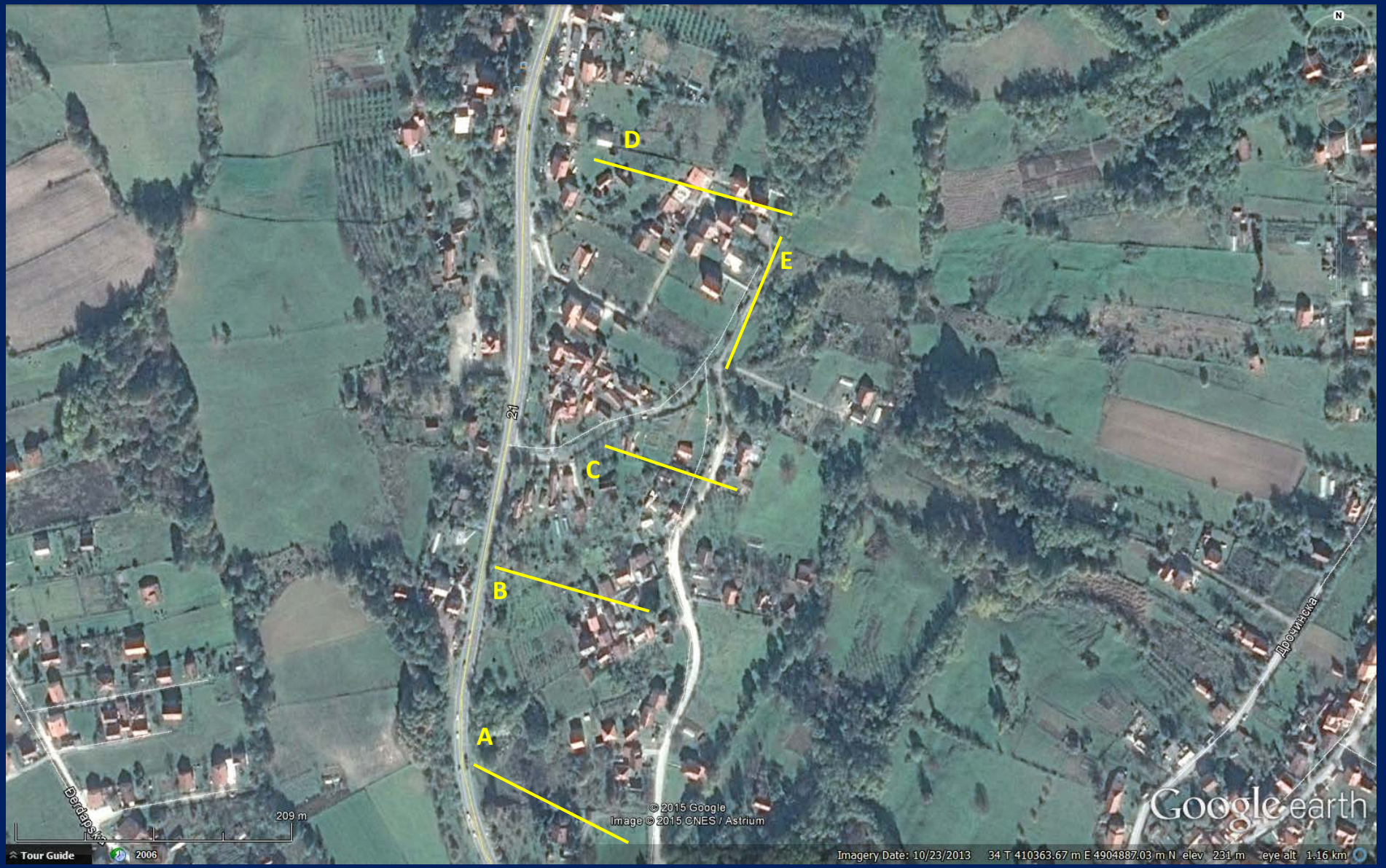
Geoscientists *without* Borders - Field Data Acquisition Seismic



Geoscientists *without* Borders Resistivity Survey

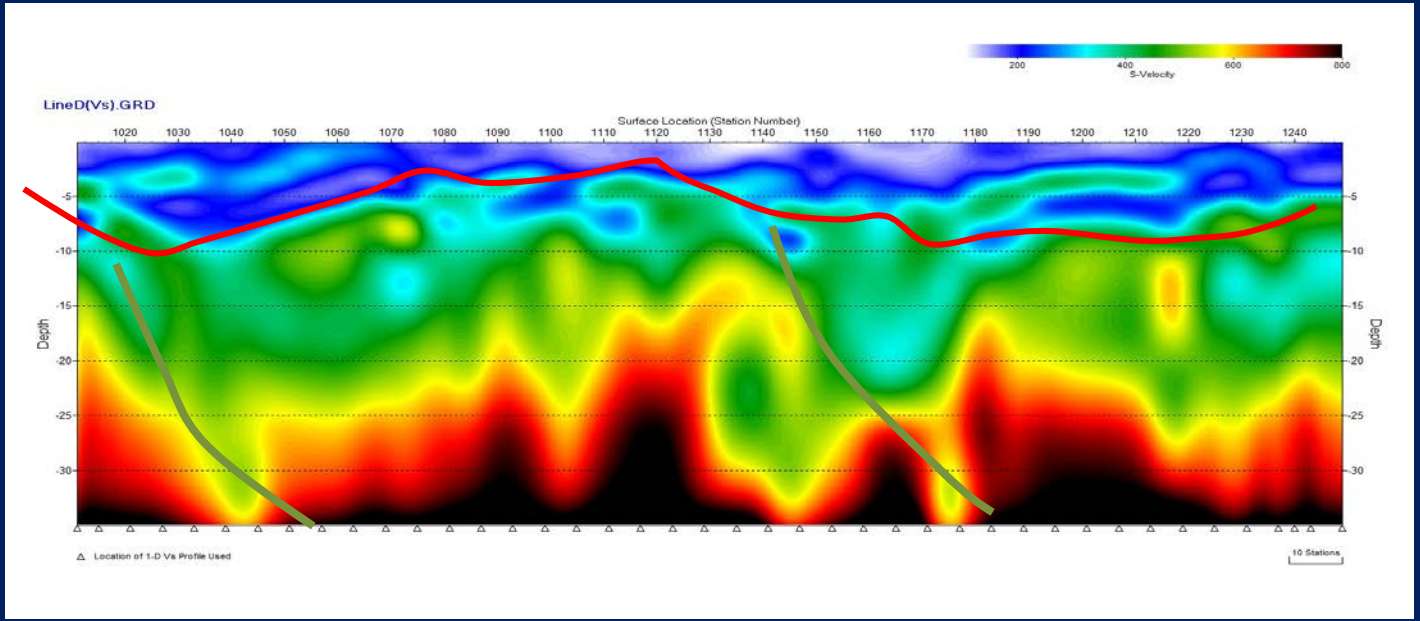
Geoscientists *without* Borders Resistivity Survey

Geoscientists *without* Borders - Evening Sessions

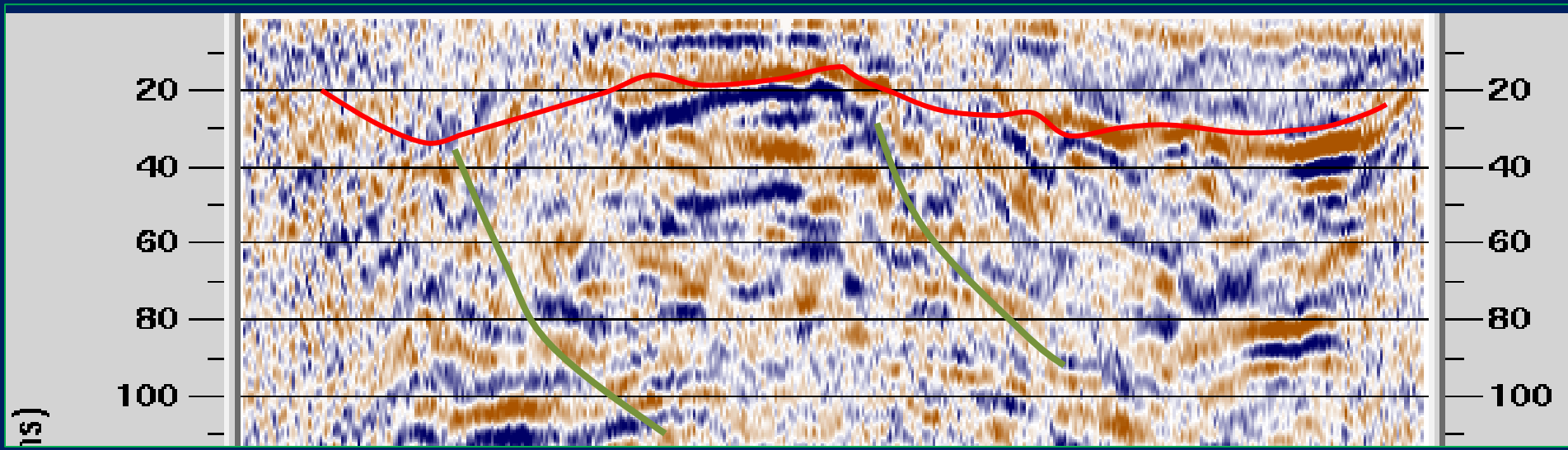

D
E
C
B
A
21
209 m
© 2015 Google
Image © 2015 CNES / Astrium
Google earth
Tour Guide
2006
Imagery Date: 10/23/2013 34 T 410363.67 m E 4904887.03 m N elev 231 m eye alt 1.16 km

100m approx

Vs section by MASW

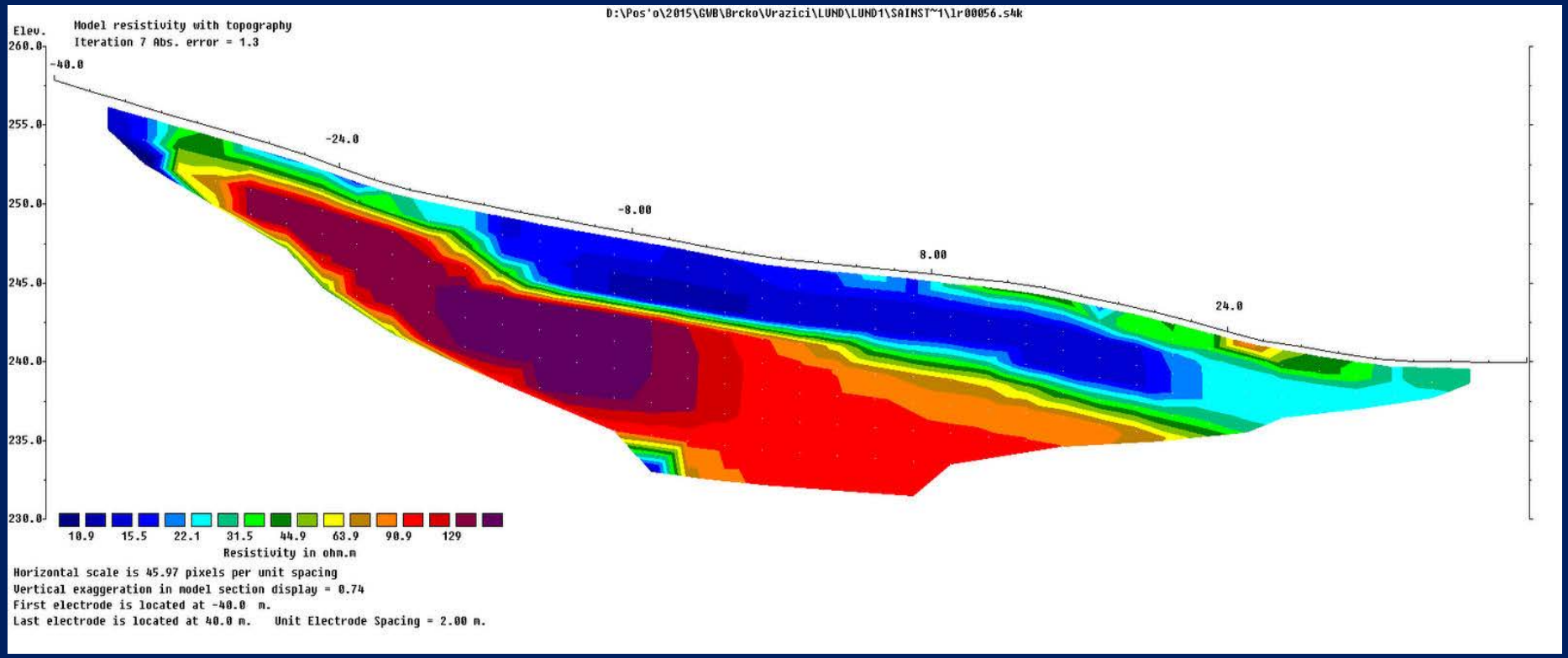


Vp Brute Stack



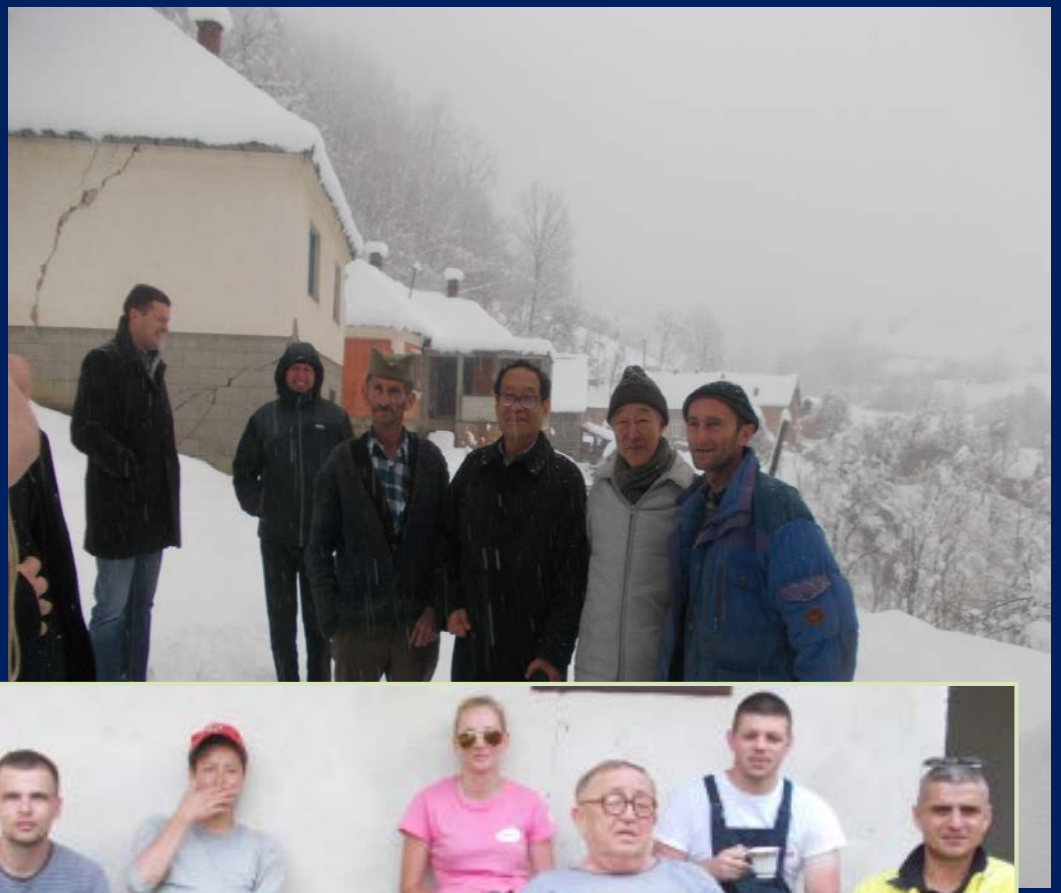
Geoscientists *without* Borders

Resistivity Section – Brcko Line 2



Geoscientists *without* Borders

Geoscientists *without* Borders



Geoscientists *without* Borders

I enjoy working in near-surface geophysics

I like working with young students and lead them to geophysics.

I enjoy working in near-surface geophysics

I like the feeling that I am a part of human community.

Summary

Physics
Observation and theoretical development

Mathematics
Language to describe the phenomenon
Does not offer solution

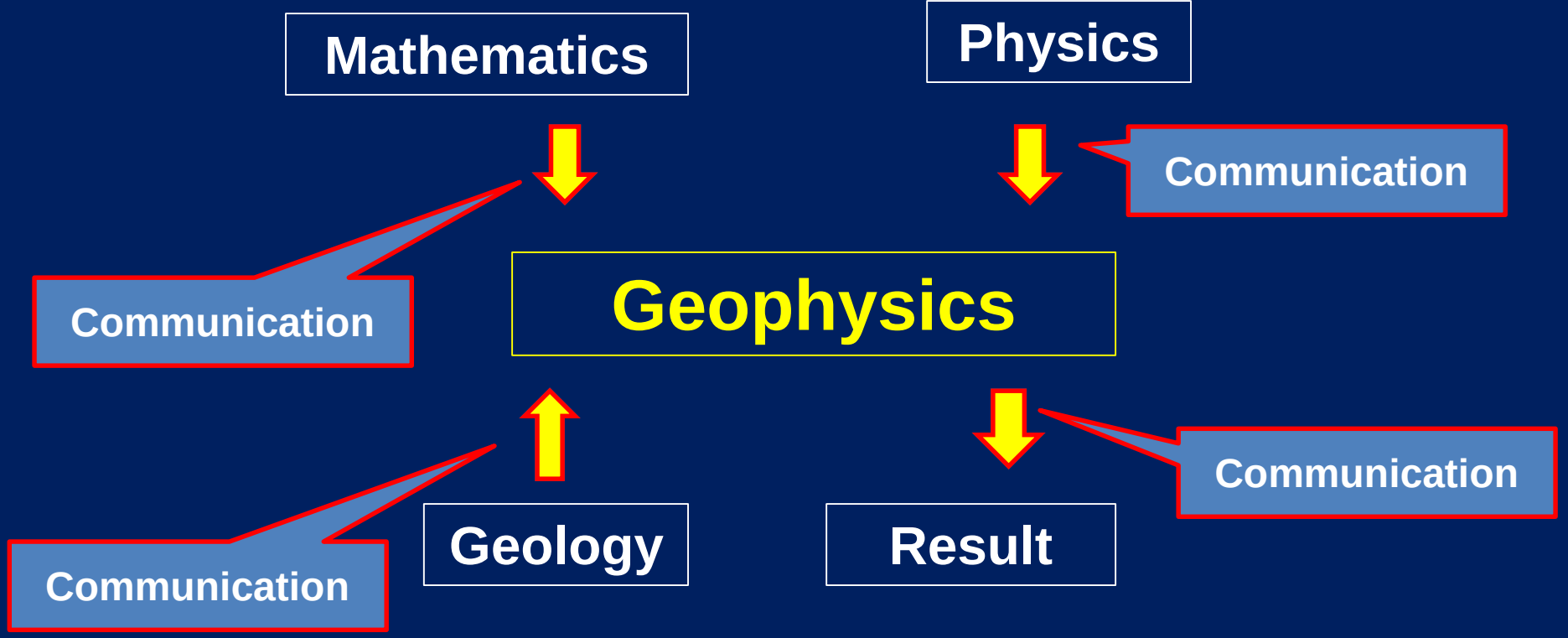
Geophysics
Data acquisition – processing
Analysis - Interpretation

Computer
Calculation power

Geology
Reality check

Result
Scientific knowledge
Economic reward
Safe community

What to study ?



Communication

- Ability to express
- Ability to hear and understand

  - **English** Common language among scientists
  - Training to accurately express what you want to say in **your own language**.

Some humanity subjects may be good to learn
Philosophy, geography, cultural study - arts

Be a good human being before being a geophysicist.

Geophysics :

- is a subject with a lot of fun
- offers a lot of challenge
- You need to understand the concepts
- Analytical solution is nice to have but not always expected
- Open to a broad spectrum of knowledge and critical mind
- Be curious and ambitious

This Hitchhikers Guide is just a guide – not a gospel

More information

Society of Exploration Geophysicists
www.seg.org

- European Association of Geoscientists and Engineers
  www.eage.org

- Australian Society of Exploration Geophysicists
  www.aseg.org.au

- Google

- Ask your teachers

Thanks for Attendance

and

Enjoy Your Study

Geophysics is a subject with a lot of fun

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Australian Society of Exploration Geophysicists