Webinar Geophysics Curriculum

ITS Surabaya

Geophysics Education

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Topics

- Introduction
- Basic Competencies – Fundamentals
- Academic – Professional Work Balance

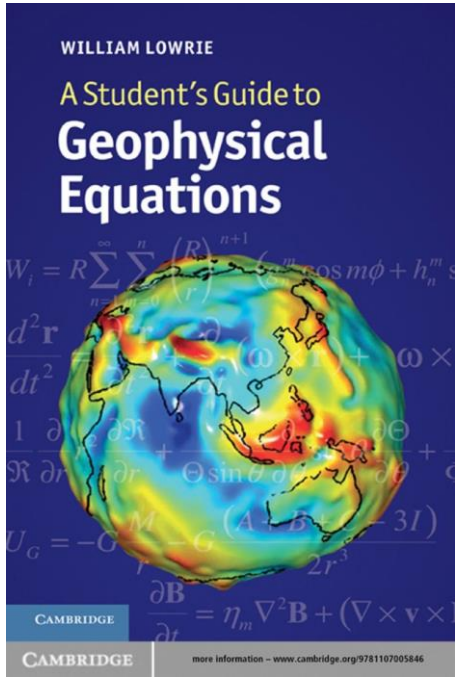
Image source: http://petr0.blogspot.com/2016/12/9-pakistan-consist-of-namely-on-onshore.html

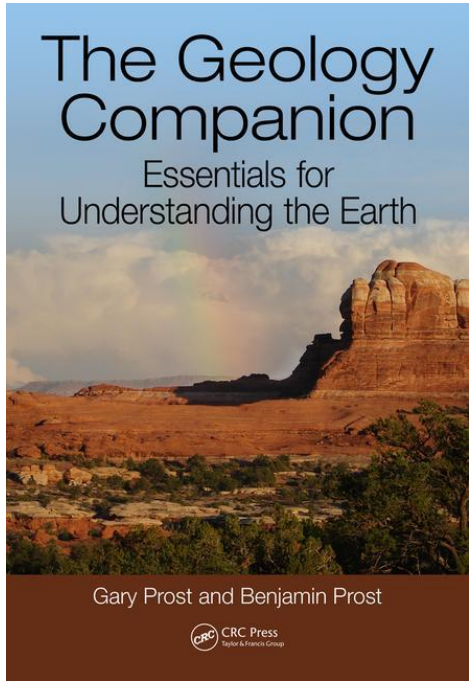
Suggested further reading & references

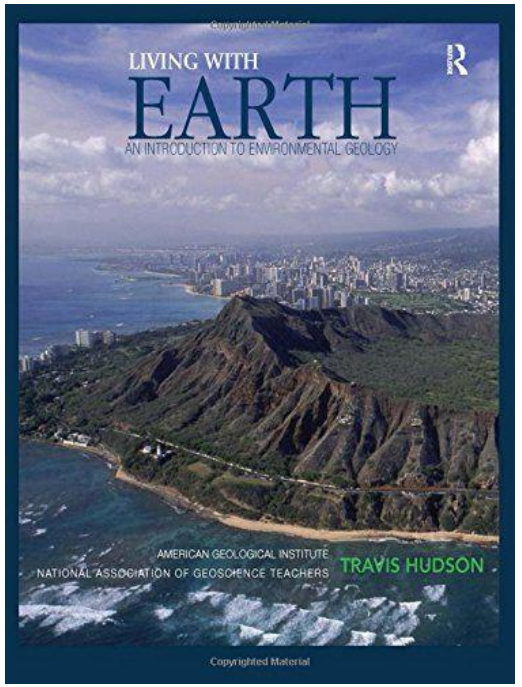
Fattahi, B., A.S. Murer, and G.A. Myers, 2003. Technical Competencies for Geoscience Professionals, SPE Western Regional/AAPG Pacific Section, 19–24 May 2003

Colin J. Campbell and Jean H. Laherrère, 1998. The End of Cheap Oil, Scientific American, 78-84, March 1998.

Uso Bardi, 2019. Peak oil, 20 years later: Failed prediction or useful insight? Energy Research & Social Science 48 (2019) 257–261







Topics

- **Introduction**
- Technical Competencies for Geoscience Professional
- Academic – Professional Work Balance

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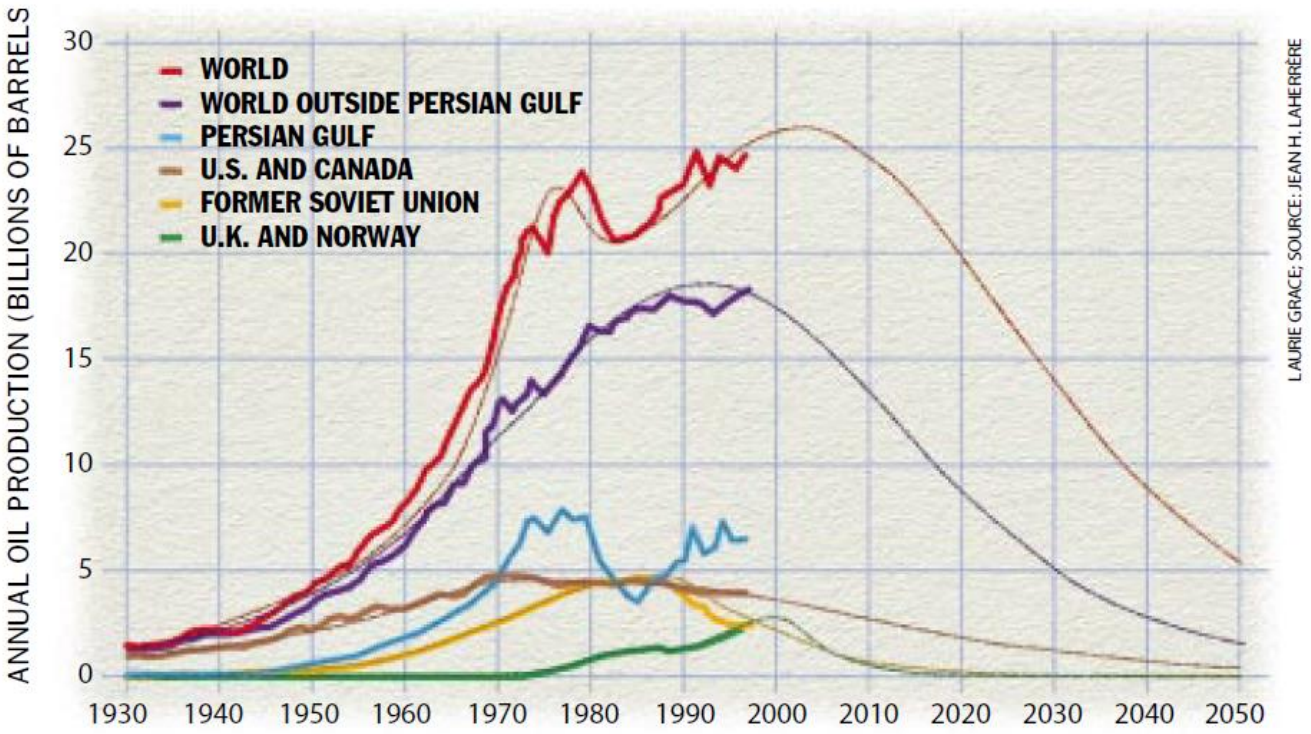
Between Past – Today …



Campbel and Laherrère, 1998

Campbell and Laherrère updated Hubbert's model with new reserve estimates and proposed that the world's crude oil production would peak around 2004–2005, and then start an irreversible decline.

Shortly afterward, Colin Campbell proposed the term "peak oil" for the highest global oil production level. The term was to become popular over the following decade, generating a true movement of ideas sometimes called the "peak oil movement."

Today, these predictions turn out to have been only partially correct, mainly because the role of "non-conventional" oil was underestimated. (Bardi)

"Live in each season as it passes; breathe the air, drink the drink, taste the fruit, and resign yourself to the influence of each."
(Henry David Thoreau)

More critical task for Geoscientist more ever than before!

Topics

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Basic Competencies - Fundamentals

- Geophysics is the application of physics to the study of the Earth.
- Worldwide geophysical observations of **the properties and behaviour of the Earth made in laboratories and observatories**, from ships, aircraft, satellites, and in boreholes, have led to a revolution in our **understanding of the physics of the Earth's interior, how it works, its hazards and their mitigation**.
- Technological and computing advances have increased our ability to make refined investigations of geological structure and physical properties beneath the surface at depths ranging from the centre of the Earth to those required for the exploration for the
  - ***oil, gas, geothermal energy, water, and other raw materials essential for human survival;***
  - ***environmental monitoring;***
  - ***civil engineering;***
  - ***the disposal of CO2 and nuclear waste;***
  - ***military activity;***
  - ***the location of archaeological remains; and forensic science including the monitoring of test-ban treaties***.

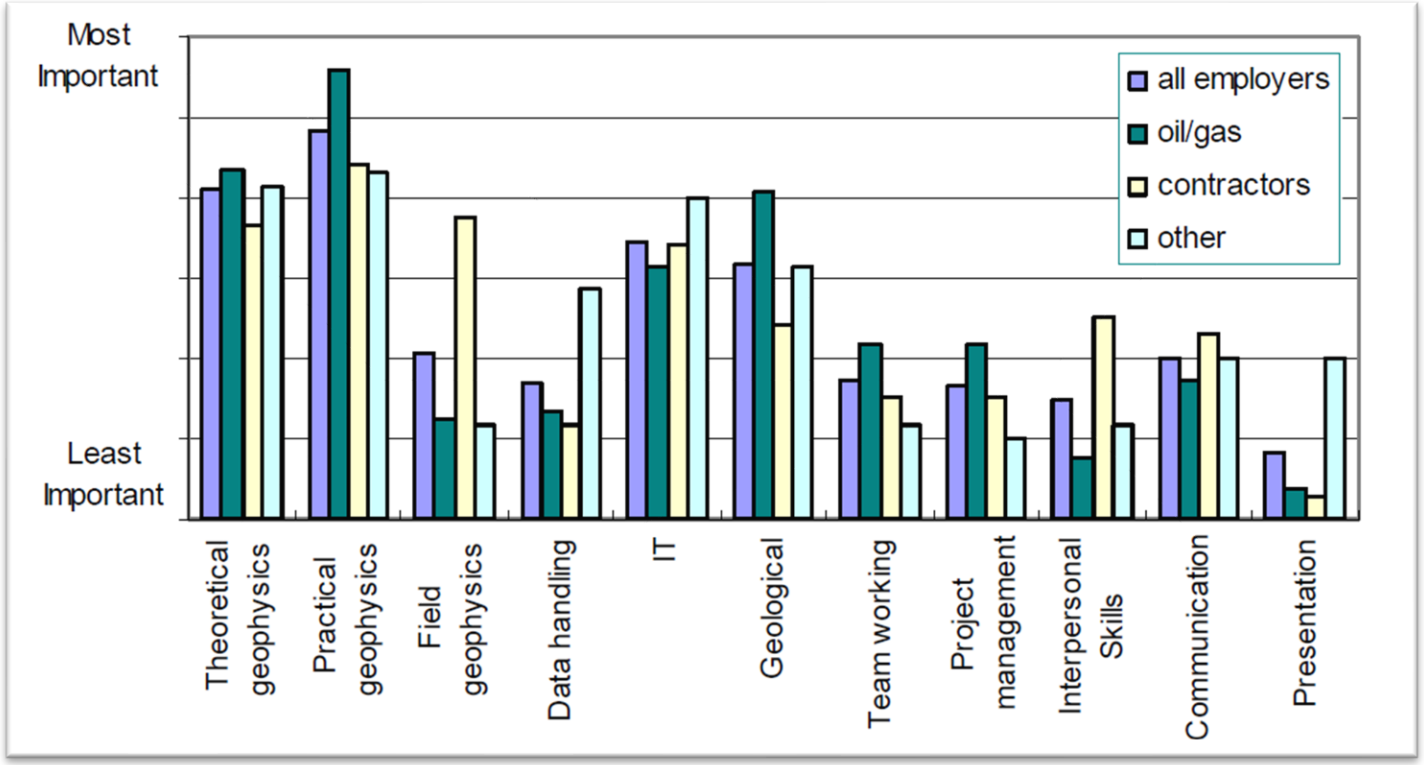
Basic Competencies - Fundamentals

- The skills base, developed through university degrees in geophysics since the 1960s and 70s, has significantly contributed to the wealth of the nation (through exploration and exploitation of natural resources) as well as to national environmental concerns, safety, and security.
- Development of programmes that will impart geophysical knowledge and skills to the next generation are vital for our future needs.
- ‘With the emphasis on the planet today, youngsters must understand that geophysics is at the centre of the issues of
  - climate change
  - natural disasters and
  - also the future of energy resources,

  where we are desperately struggling to find more geophysicists.’ President EAGE

Basic Competencies - Fundamentals

- Technical – Professional



- Personal - Social

The **ability to work within an integrated technical team** (or asset). So obvious is the need for this skill in today's any (incl. petroleum) industry that it is not specified on the geophysics matrix.

Although this skill can certainly be improved through on the job experience(s) and specialized training, many people either possess the ability to "work well with others" in a collaborative setting, or they don't.

In today's competitive world, the ability to work constructively with geologists as well as reservoir, production and drilling engineers is not a desirable trait, but rather a required trait.

The bottom line is that companies covet geophysicists with excellent **people skills**.

Basic Competencies - Fundamentals

Table 1. General Knowledge/Skill			
Months of Experience	Minimum Competence		Above Minimum Competence
Task	Breadth	Depth	
1-12	Understand and use petroleum engineering terminology	Understand general terminology of all sub-disciplines.	Understand terminology specific to the sub-discipline.	Understand terminology in areas of expertise.
1-12	Perform duties in ethical manner	Understand the ethical code of behavior for the general practice of engineering.	Demonstrate ethical behavior in sub-discipline.	Provide leadership in ethical behavior across disciplines.
1-12	Promote engineering professionalism	Maintain membership in technical and professional societies and pursue professional license/certification.	Participate actively in technical and professional societies and obtain professional license/certification.	Encourage others in industry to join and actively participate in technical and professional societies and to become licensed or certified.
12-36	Identify and use relevant industry and company design standards	Identify what design standards exist in all sub-disciplines.	Understand and use conventional design standards specific to the sub-discipline.	Help create design standards as well as apply standards to non-conventional applications.
12-36	Maintain regulatory compliance	Identify what regulatory bodies have jurisdiction and where to find documentation of the applicable regulations.	Complete necessary regulatory permitting and reporting specific to the sub-discipline.	Work with regulators on rule changes and exceptions.
12-36	Identify and use technical software and informational databases	Identify what technical software and informational databases exist in all sub-disciplines.	Understand and use conventional technical software and informational databases specific to the sub-discipline.	Help create technical software and informational databases as well as apply technical software and informational databases to non-conventional applications.
12-36	Monitor operations and optimize performance	Understand basic monitoring/optimization techniques.	Perform conventional operations monitoring specific to a sub-discipline and make optimization recommendations.	Perform operations monitoring in areas of expertise or across sub-disciplines and make recommendations to optimize system performance.
12-36	Evaluate economics of project	Understand basic economic principles (PV analysis, lease vs. purchase, etc.).	Perform economic evaluations of projects within the sub-discipline.	Perform economic evaluations across sub-disciplines or in specialty areas within a sub-discipline.

Example of required general competency in a petroleum industry for a first year engagement

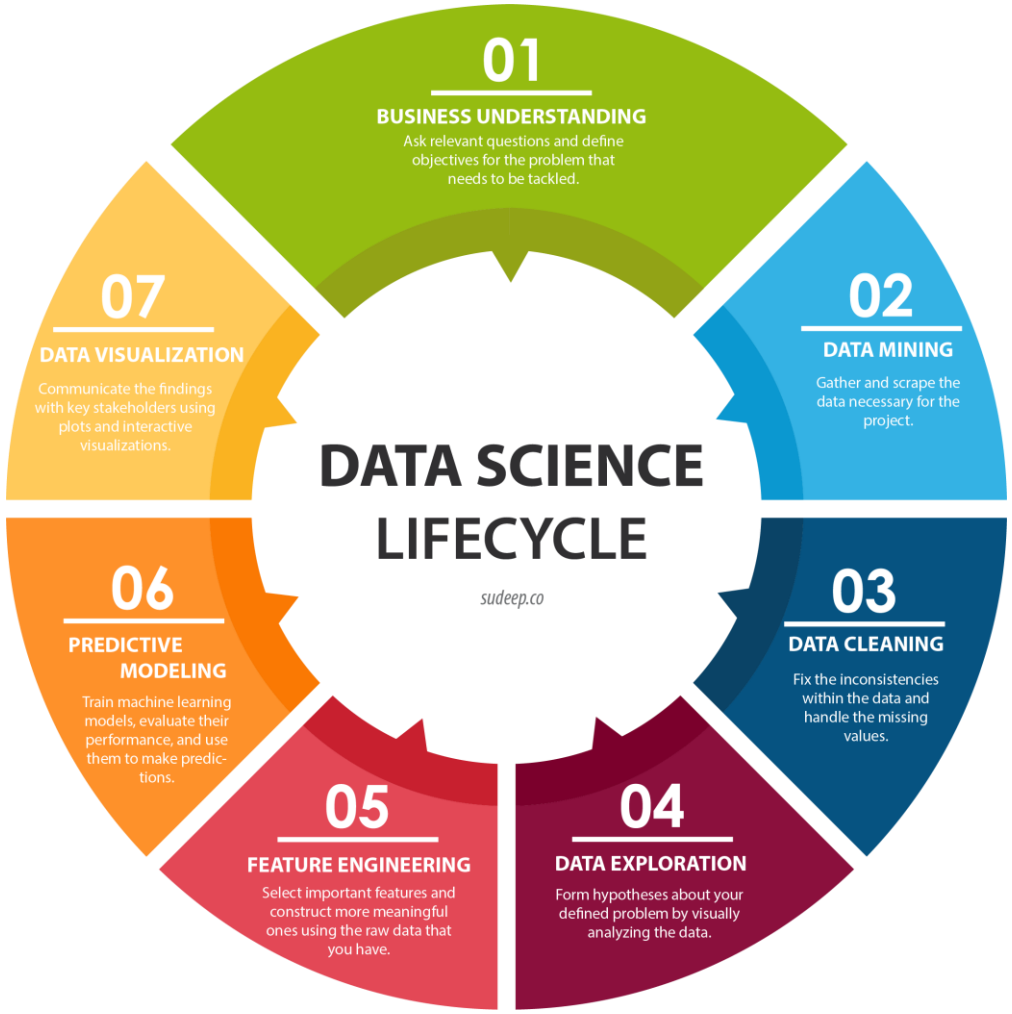
Basic Competencies - Fundamentals

Table 9. Geophysical Knowledge/Skill

Months of Experience	Task	Minimum Competence		Above Minimum Competence
		Breadth	Depth	
1-12	Perform basic seismic data Interpretation	Able to complete basic structural and/or stratigraphic seismic interpretation and map prospective reservoirs, seals, and associated faults.	Tie loops using vertical profiles, time slices and well data; and generate maps of interpreted horizons and faults. Basic understanding of 2D and 3D seismic data acquisition and processing	Ability to understand and apply multiple seismic data volumes (seismic attributes, inversion, models, coherence processing, etc..) to better quantify the interpretation and subsurface geology.
1-12	Computer Workstation Skills	Perform seismic interpretation and reservoir characterization using PC or Unix based workstation.	Use computer workstation and geophysical software to effectively load, interpret and map seismic and well data; process and manipulate raw and interpreted data and export results digitally or in hardcopy form to geologic or reservoir modeling software packages.	In-depth knowledge of multiple operating/hardware systems and software packages as well as a proficient knowledge of Unix and Linux language. Manage multiple seismic projects, import/export seismic/well data and interpreted structural and stratigraphic features to/from database or linked projects.

Example of required geophysical competency in a petroleum industry for a first year engagement

Far beyond – Ability to change and adapt – Industry 4.0/5.0



It's **not** just a matter of programming skill → sense of self development

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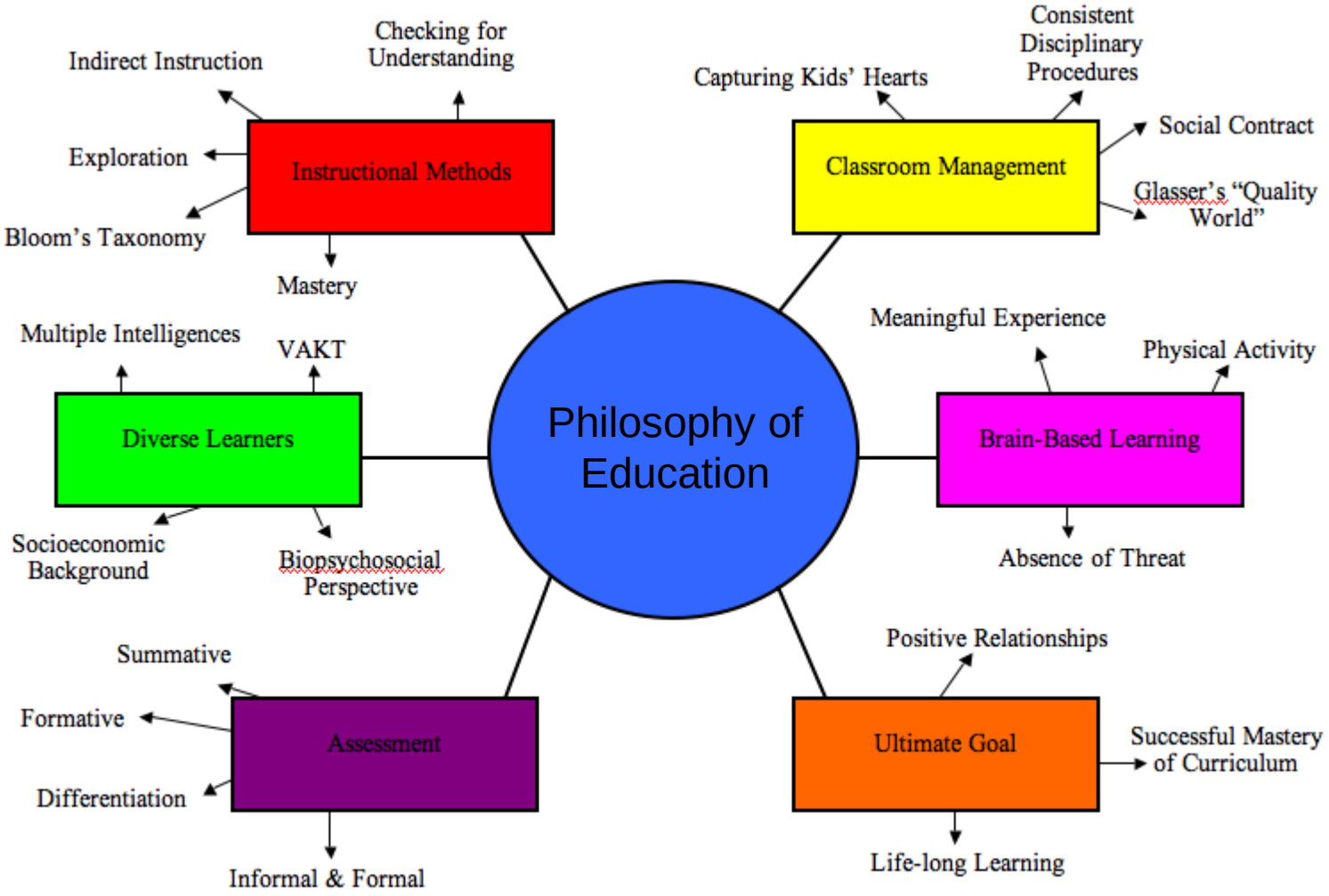
Academic – Professional – Personal Life Balance



- Brain-based Learning
- Classroom Management
- Instructional methods
- Diverse Learners
- Assessment
- Ultimate Goal

Modified from Kelsey F. Hewitt, "Philosophy of Education"

Terima Kasih

Experience & engagement

2006–2008

Integrated Geophysical Exploration Technology (I-GET)

- Stress and temperature dependence of rocks

2007–2008

Enhanced Geothermal Innovative Network for Europe (ENGINE)

- Seismo-acoustic signatures of rocks saturated with supercritical fluids

2008–2009

MeProRisk – a Tool Box for Evaluating and Reducing Risks in Exploration, Development, and Operation of Geothermal Reservoirs

2010–2013

Semi-permanent passive seismic data monitoring: acquisition and imaging 3D data

2016–2018

Induced seismicity risk assessment due to gas injection/production in Groningen – Shell/NAM/Warmestad

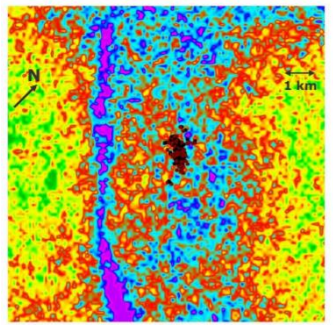
2017–2018

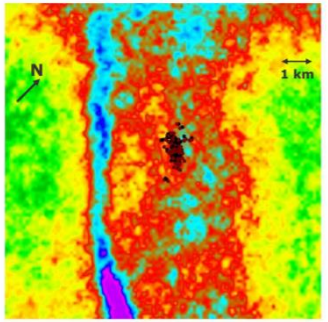
Field stress estimation and induced seismicity risk mapping for underground gas storage in Spain – ENAGAS

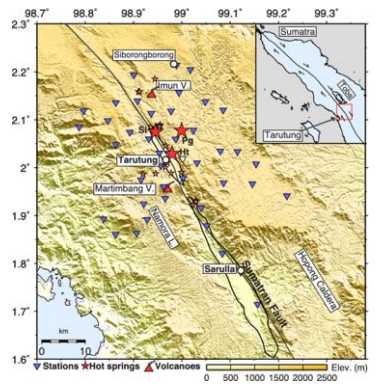
2019-

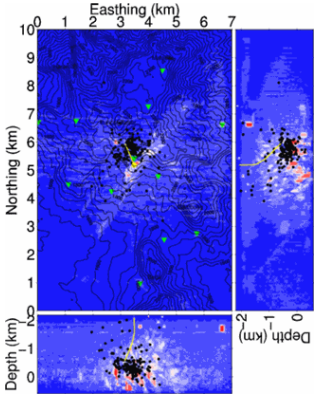
PETRONAS Research

SIXTH FRAMEWORK PROGRAMME



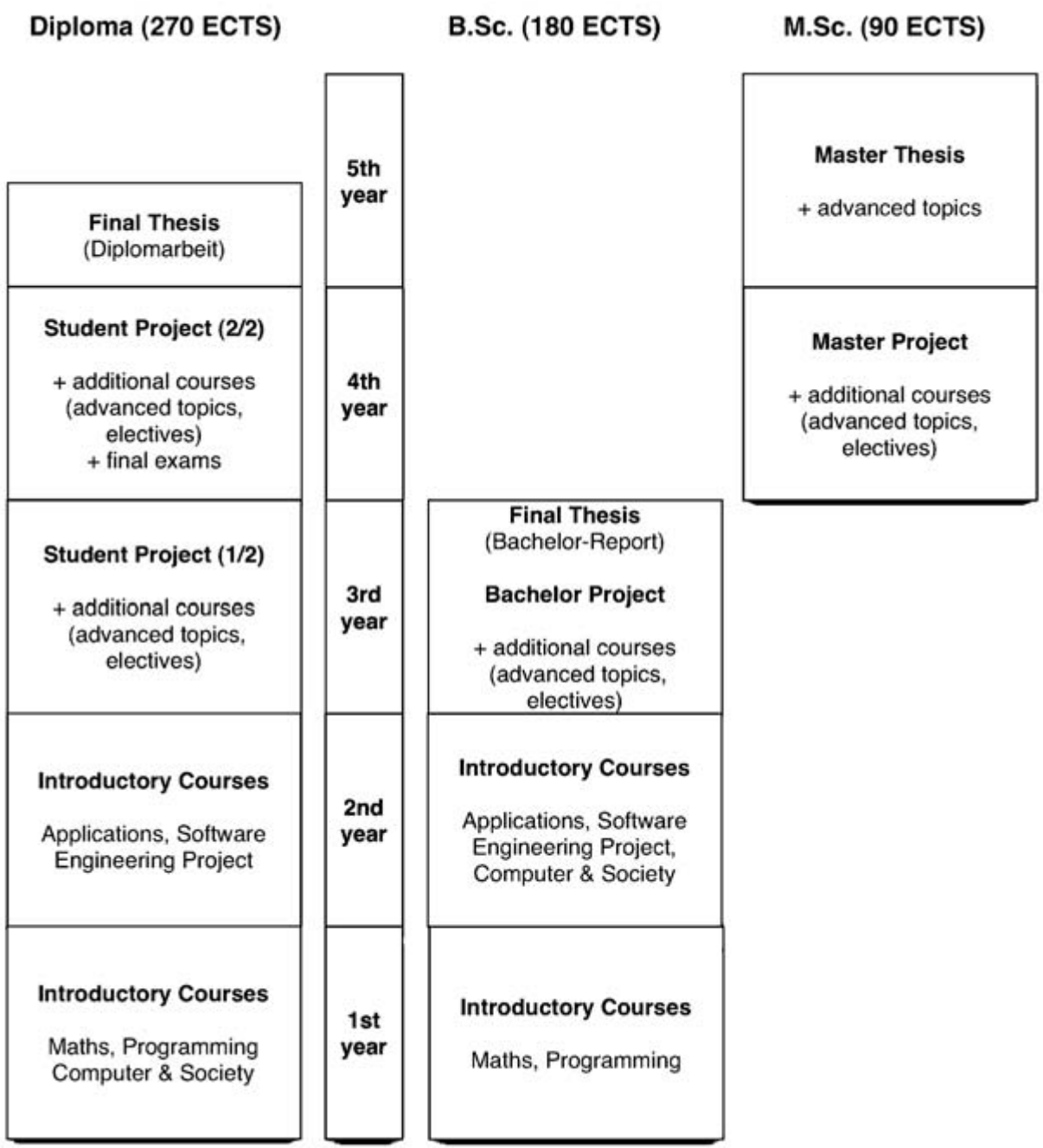






Reference: Rock property

K	E	λ	v	M	μ
$\lambda + 2\mu/3$	$\mu\frac{3\lambda+2\mu}{\lambda+\mu}$	—	$\frac{\lambda}{2(\lambda+\mu)}$	$\lambda + 2\mu$	—
—	$9K\frac{K-\lambda}{3K-\lambda}$	—	$\frac{\lambda}{3K-\lambda}$	$3K - 2\lambda$	$3(K - \lambda)/2$
—	$\frac{9K\mu}{3K+\mu}$	$K - 2\mu/3$	$\frac{3K-2\mu}{2(3K+\mu)}$	$K + 4\mu/3$	—
$\frac{E\mu}{3(3\mu-E)}$	—	$\mu\frac{E-2\mu}{(3\mu-E)}$	$E/(2\mu) - 1$	$\mu\frac{4\mu-E}{3\mu-E}$	—
—	—	$3K\frac{3K-E}{9K-E}$	$\frac{3K-E}{6K}$	$3K\frac{3K+E}{9K-E}$	$\frac{3KE}{9K-E}$
$\lambda\frac{1+v}{3v}$	$\lambda\frac{(1+v)(1-2v)}{v}$	—	—	$\lambda\frac{1-v}{v}$	$\lambda\frac{1-2v}{2v}$
$\mu\frac{2(1+v)}{3(1-2v)}$	$2\mu(1 + v)$	$\mu\frac{2v}{1-2v}$	—	$\mu\frac{2-2v}{1-2v}$	—
—	$3K(1 - 2v)$	$3K\frac{v}{1+v}$	—	$3K\frac{1-v}{1+v}$	$3K\frac{1-2v}{2+2v}$
$\frac{E}{3(1-2v)}$	—	$\frac{Ev}{(1+v)(1-2v)}$	—	$\frac{E(1-v)}{(1+v)(1-2v)}$	$\frac{E}{2+2v}$
$M - \frac{4}{3}\mu$	—	$M - 2\mu$	$\frac{M-2\mu}{2(M-\mu)}$	—	—


Diploma (270 ECTS)
B.Sc. (180 ECTS)
M.Sc. (90 ECTS)
5th year
4th year
3rd year
2nd year
1st year
Final Thesis
(Diplomarbeit)
Student Project (2/2)
+ additional courses
(advanced topics,
electives)
+ final exams
Student Project (1/2)
+ additional courses
(advanced topics,
electives)
Introductory Courses
Applications, Software
Engineering Project
Introductory Courses
Maths, Programming
Computer & Society
Master Thesis
+ advanced topics
Master Project
+ additional courses
(advanced topics,
electives)
Final Thesis
(Bachelor-Report)
Bachelor Project
+ additional courses
(advanced topics,
electives)
Introductory Courses
Applications, Software
Engineering Project,
Computer & Society
Introductory Courses
Maths, Programming