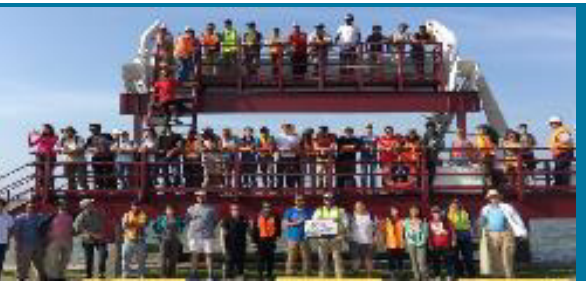
The new 4H Club: Hydro, heat, hydrogen, hurricanes, and other geophysical headings



Robert R. Stewart

University of Houston

Earth & Atmospheric sciences

CREWES

34th Annual CREWES Meeting

December 1st, 2022
Banff, Alberta

Allied Geophysical Laboratories
UNIVERSITY of HOUSTON

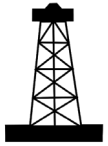
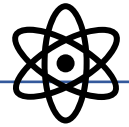
The 4H Club (Head, heart, hands, and health) originally for agriculturally oriented education & advancement

Learn To Do By Doing

- Where is geophysics applied now?
- Where are the future needs, jobs, and excitement?
- What are new energy and resource types?
- Where is applied geophysics going?

Classic geophysics: Image, find, and understand anything under the surface

Subsurface geophysics



Economic

- Find and produce energy & resources

- Make $

- Provide for human needs; Enhance prosperity; applied

- SEG, AAPG, EAGE

Hazards & infrastructure

- Understand and mitigate earthquakes, volcanoes, floods, CO2, waste; build properly

- Avoid losing $

- Save lives and facilities; applied

- AGU, EEGS

Curiosity & interest

- Understand nature (deep Earth, planets)

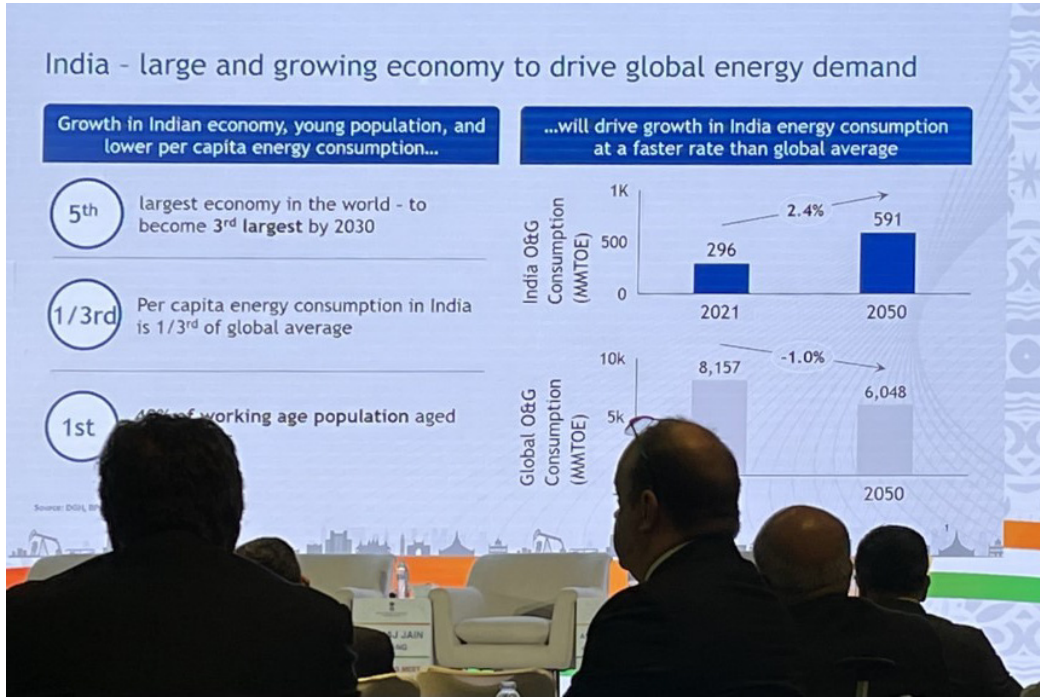
- Costs $

- Long-term benefits; academic

- AGU

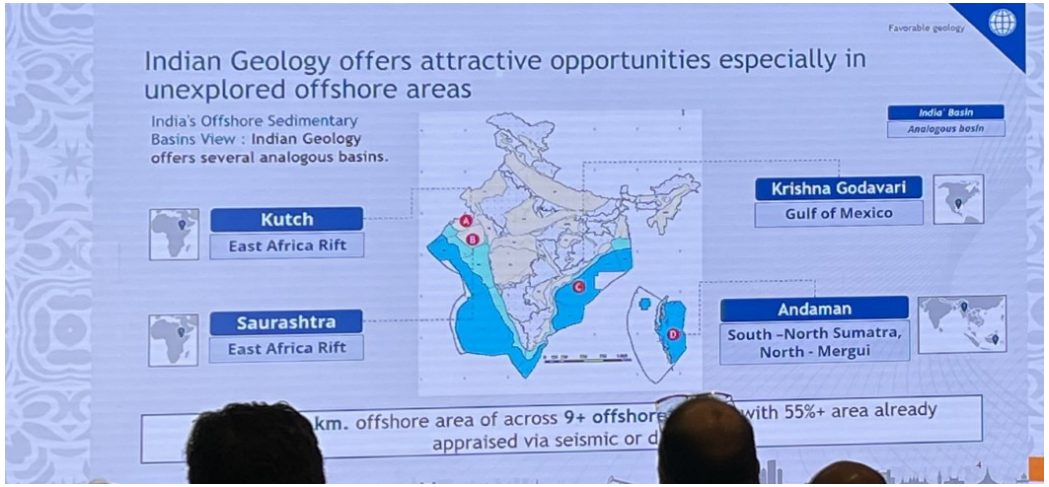
(Stewart, 2020)

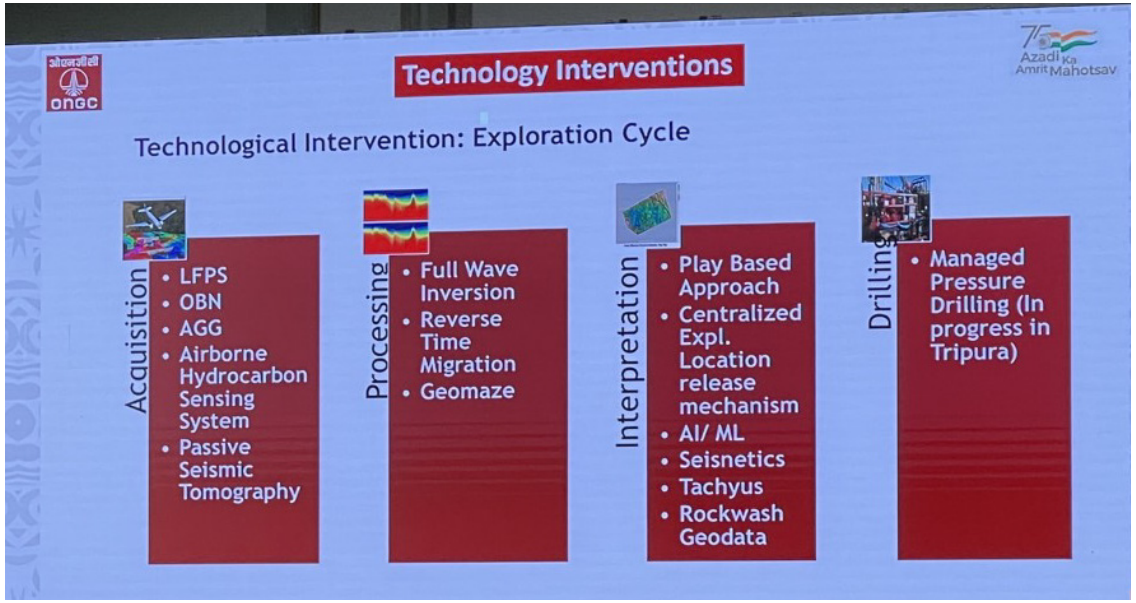
Energy and reality (India as an example)



Need for & future of hydrocarbons > enormous!

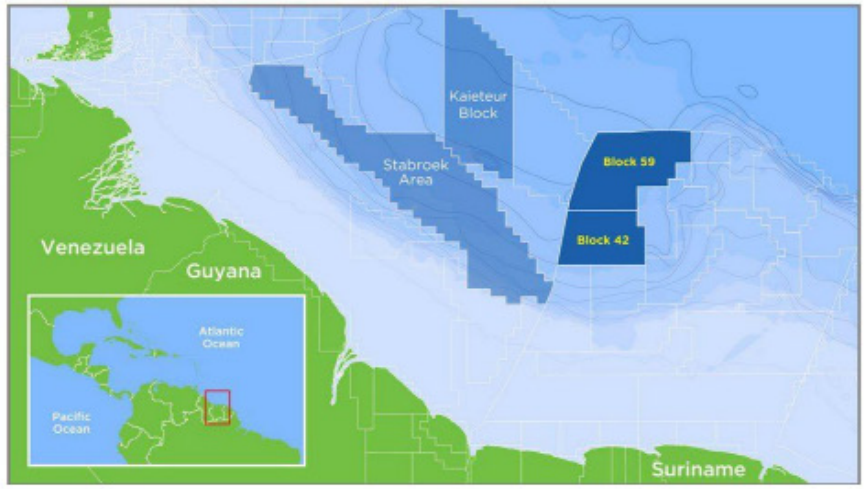
- India, Guyana/Surinam
- Traditional and innovating geophysics

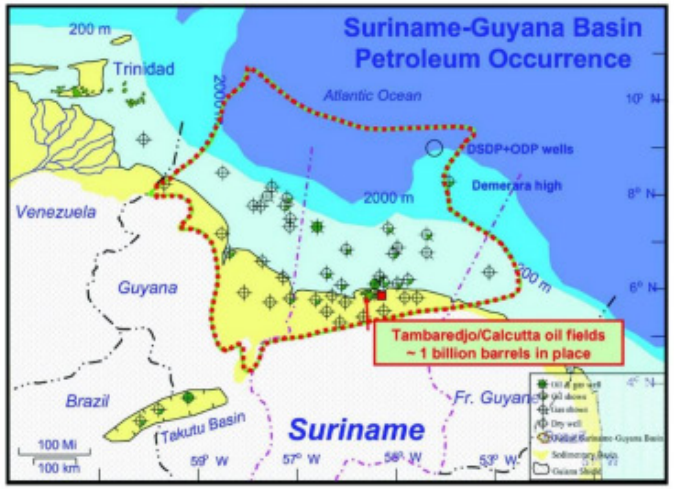


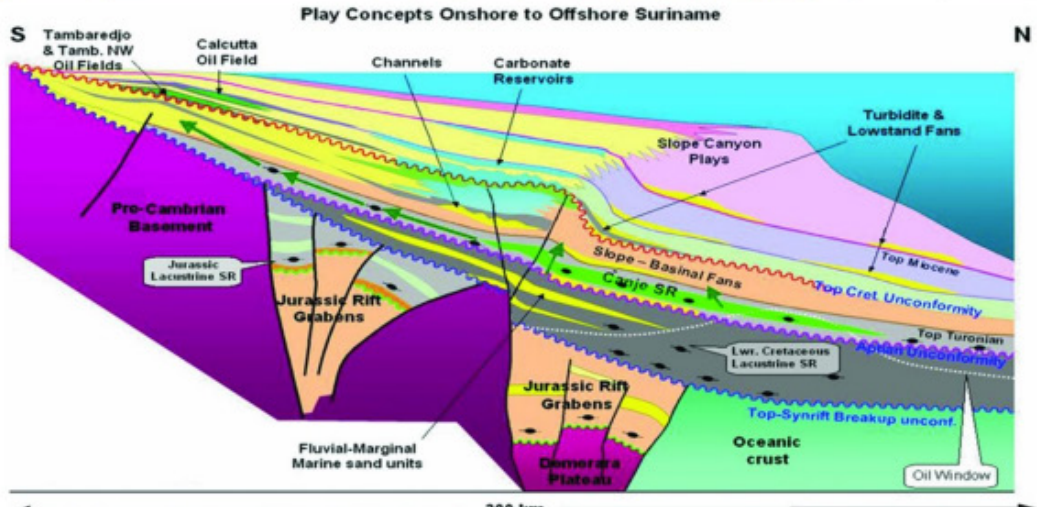


Guyana and Surinam – remarkable exploration & discovery

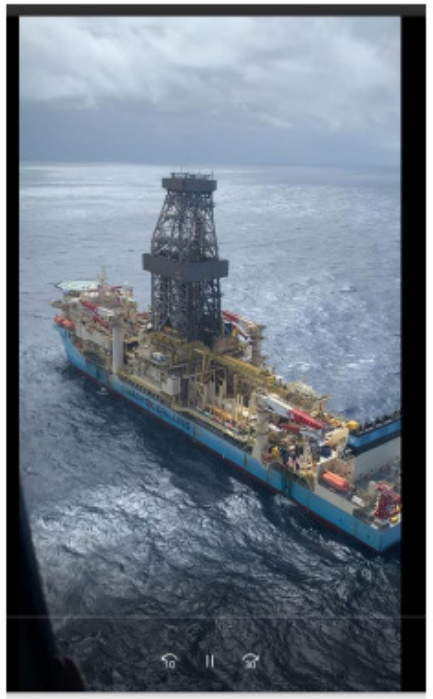
Interesting technology and plays in northern South America







- Maersk Valiant drilling vessel (10,000 ft water; 20,000 ft sub-bottom) with Apache



Suriname helicopter video.mov

(Staatsolie, OilNow Offshore, 2022)

Humans > corn/rice, digestion, activity, effluent, sanitation
Machines > hydrocarbons, combustion, activity, effluent, sanitation

- Hydrocarbons will rule for a long time

What are some sustainable energies?

- Hydro/water: H_2O movement (also a resource)
- Heat/geothermal
- Hydrogen & helium (energy & resource)
- Hurricanes/wind

Energy lexicon: Renewable, alternative, & sustainable

- Renewable = generated at higher rates than consumed; replenishes relatively fast (e.g., geothermal, hydro, wind, solar)
- Alternative = non-fossil (nuclear and renewables)
- Sustainable = meeting ongoing requirements without compromising future needs and the environment; manageable, copacetic rate without end
- Carbon neutral – full life cycle of effort doesn't liberate additional carbon to the atmosphere; equal carbon source and sinks

Sustainable energies

- Hydro/water
  - H_2O movement generating electricity through a turbine (dam, diversion, or pumped)
  - Water movement using tidal or wave power


(J. Hopkins, 2021)

- Substantial potential
- Can have large footprint & impact


TidEA, 2022

Sustainable energies - Hydro

- Geophysics contribution
  - Remote sensing for topography
  - Soil types, construction materials
  - Shallow stratigraphy & structure
  - Regional and induced seismicity
  - Dam mapping and integrity
  - Monitoring

  - Using most geophysical techniques: EM, crosswell, seismic, resistivity, …

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Sustainable energies

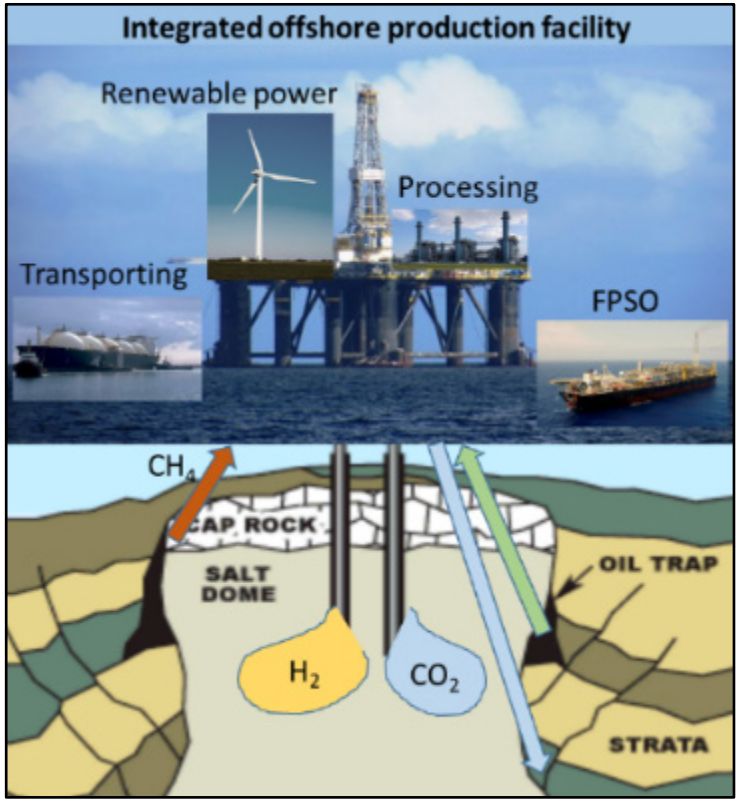
- Heat/geothermal
  - In many subsurface forms (steam, hot dry rock, magma)
  - Very large resource
  - Many appropriate geophysical techniques (EM, seismic, resistivity, …); geophysical exploration is a key factor

(Discover, 2022)

(MACH, 2022)

Sustainable energies

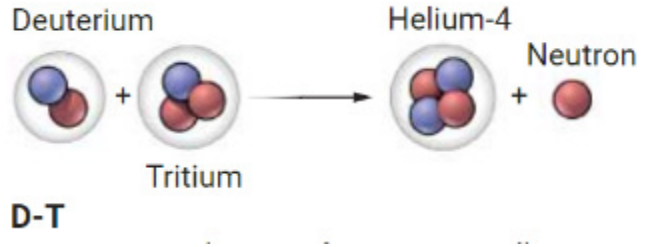
- Hydrogen
  - Energy carrier - mostly reformed from methane
  - Some exciting exploration potential for “white” or naturally occurring H_2
  - Repurposing existing facilities

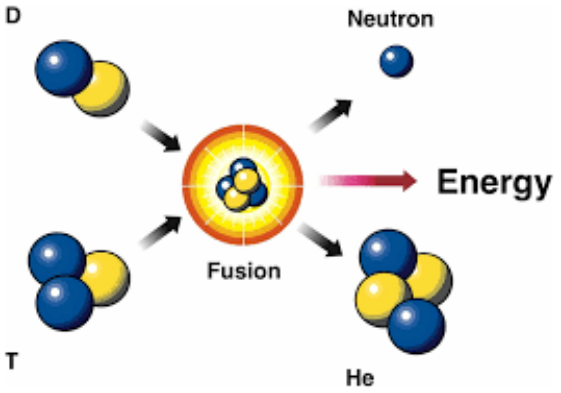


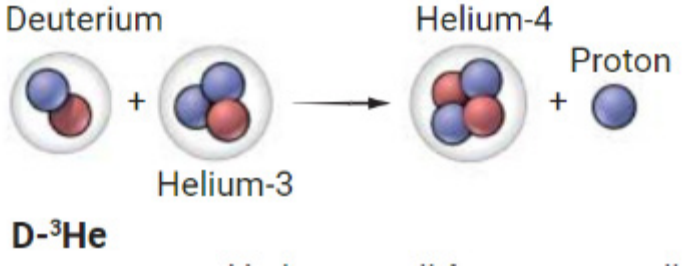
Substantial place for geophysics

The ultimate sustainable energies

- Hydrogen & helium in fusion reactions







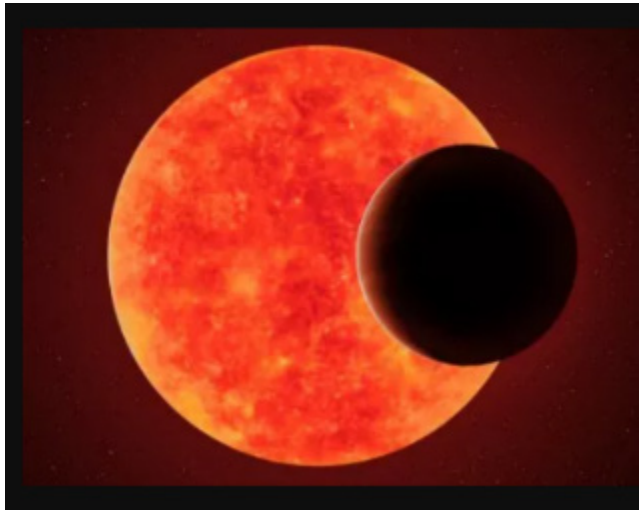
Sustainable energies

- Hurricanes/wind
  - Substantial potential with free source
  - Considerable impact with intermittency
  - Mindful of natural hazards

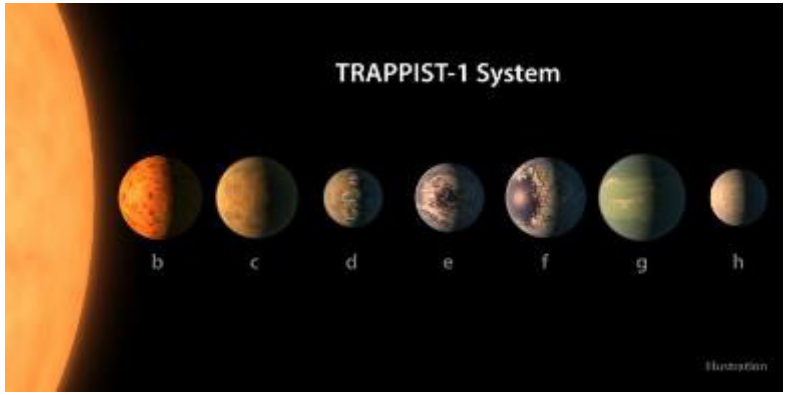
  - Mapping, vibrations, inspection, location repurposing

Way out there … Exoplanets

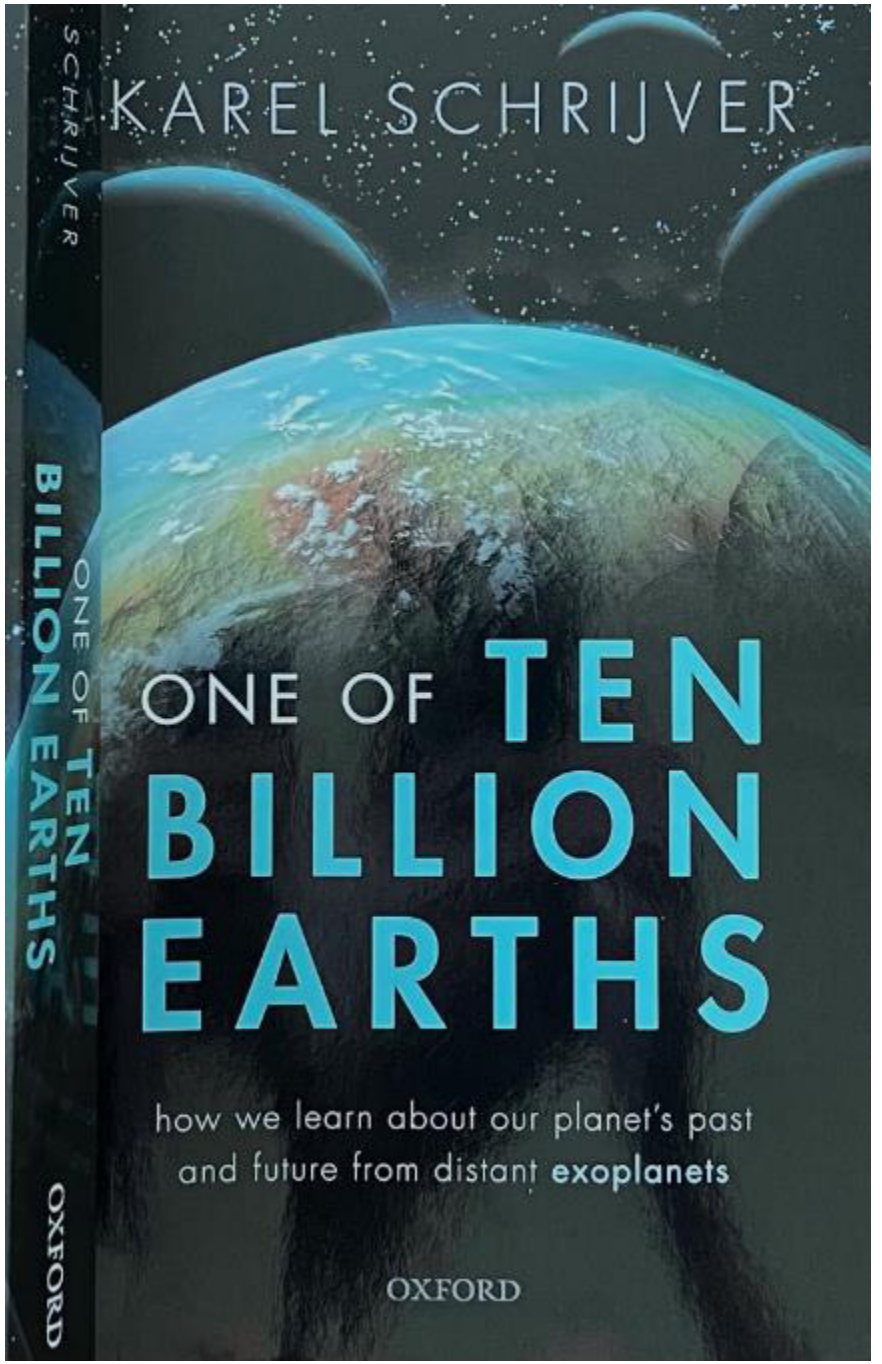
- As of December 1st, 2022, there are 5,246 confirmed exoplanets (exoplanets.nasa.gov)



Exoplanets & how to find them

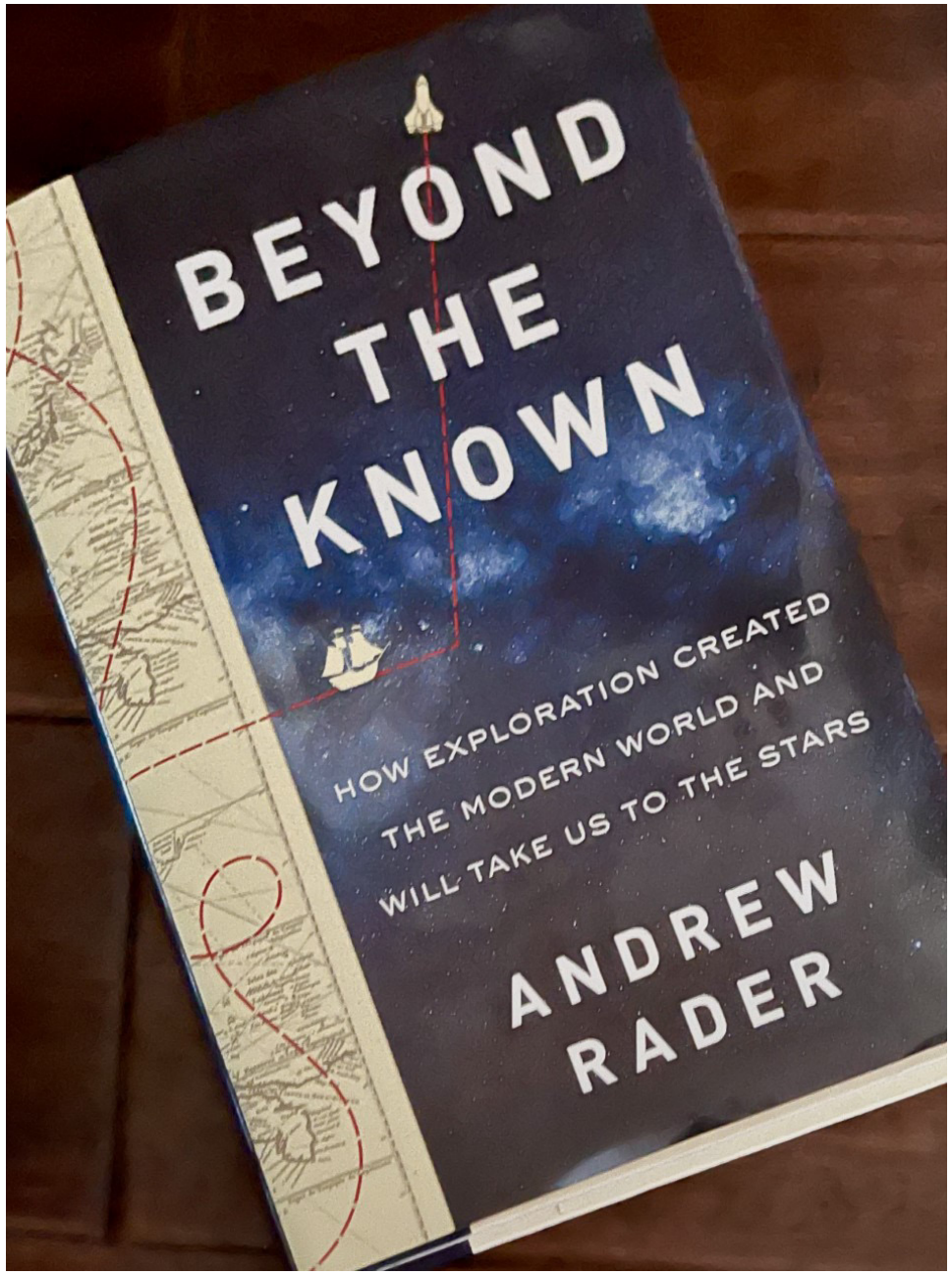


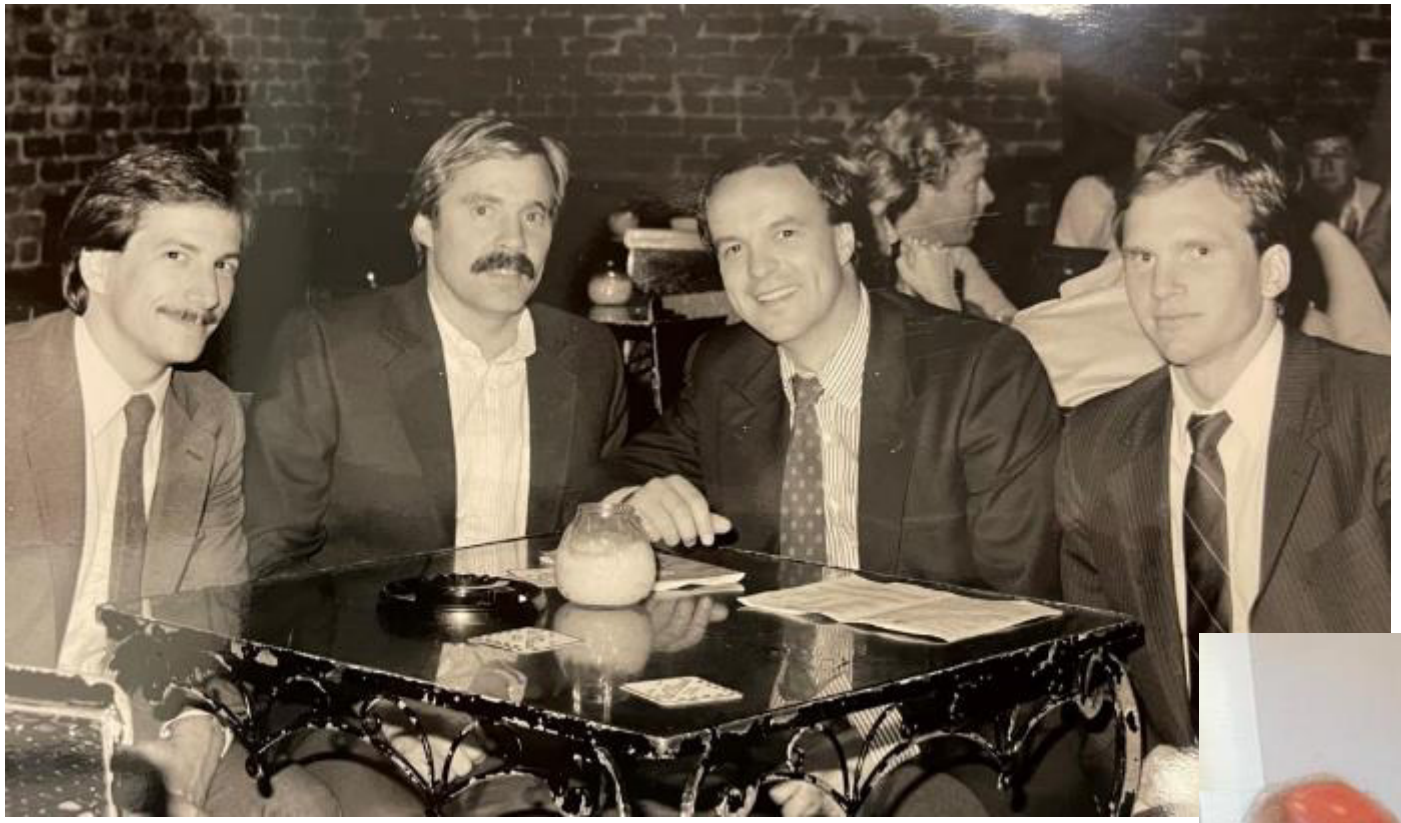
- Transit method – dimming of star with passing of planet in front of it
- Wobble (radial velocity) technique – changes in color (Doppler shift) with slight shift in star's position due to orbiting planet
- Direct observation using a powerful telescope (e.g., Webb)



Where are we going in geophysics?

- Energy
  - Hydrocarbons, hydrogen, wind, hydro, uranium, helium
- Minerals
- Infrastructure
- Archaeology, forensics, security
- Planetary resources





SEG Convention, Pat O’Brien’s, New Orleans, 1979

Geophysics across the years … where will it be in the next 40 years?

Kasra Persian Grill, Houston, 2019

Summary – Hydro, heat, hydrogen, & hurricanes

- Enormous alternative energy sources exist – all with challenges
- Finding and developing most sustainable sources requires substantial geophysics
- Major place for geophysics in upcoming energy economies
- Need to develop targeted technologies, products, and education
- Make our story known