GEOSCIENCE CAREERS

room to grow...

Bata-1 Gas Discovery, Sumatra
Photo by Chuck Caughey
THE GEOSCIENCE GRADUATE'S OPTIONS

Minerals   Oil & Gas   Environment, Engr, Other
The Internet

Kaldi, 2004
THE GENERATIONS

• Traditionalists 1925-45
  – Resistant to high tech
  – Value stable environment
  – Want to leave a legacy

• Baby Boomers 1946-64
  – Willing to learn
  – Try to build successful careers

• Generation X 1976-80
  – Adept with technology
  – Look for portable careers

• Generation Y 1981-02
  – Technologically superior
  – Respectful of tradition
  – Embrace diversity
  – Seek dual careers with spouses
Post Graduation Jobs for Geoscientists, US & Canada

Katz, 2003 AAPG

Data normalized to exclude non-geoscience employment

- Environmental: 55.2%
- Government: 14.6%
- Petroleum: 13.3%
- Teaching: 13.3%
- Research: 3.7%
Brain Drain
(top 25 US O&G Companies)

• Jobs Continued Decline (-4.1% in 2004)
  – 21,000 industry jobs lost in 2004
  – 514,000 jobs now, with record oil prices
  – 1,110,000 decline from last boom in ‘81

• Productivity Increase: Driven by Technology
  – 10.6% compound annual growth since ‘94
  – Helped offset job losses in the slowdown
  – Provides no cushion for rebound

Stats from John S. Herold study, Market Watch 19.04.05
MEDIAN AGE OF AAPG / SPE MEMBERS

Modified from Lloyd & Kaldi 2002
In the next 7 years, 40-70% of Geoscientists will be eligible to retire.

Modified from Lloyd & Kaldi 2002
US Graduate Degrees in 2004

- Lawyers: 43,000
- Geologists: 1,681

Lawyers - Gaurdie Banister, Technical Director for Shell Energy Resources, Houston Chronicle 3.05.05 p. 1; Geologists - AGI
Gasoline Price Components

Retail Price: $3.00

Profit $0.10

$0.45 Refining, Distribution and Marketing

$0.65 Federal and State Taxes

$1.80 Crude Oil

Source: U.S. Department of Energy and ConocoPhillips estimates
Dynamics of Oil Supply & Demand

- $12.75/bbl, Dec 1998*
- $143.67/bbl, June 2008

*avg for Illinois Basin, iog.com
Petroleum in Antiquity

• 3000 BC: Fertile Crescent & Baku Seeps
  –Oil seeps noted along banks of Euphrates
  –Fires of Babylon seen by Greeks, Romans
  –Azerbaijan – Persia’s land of fire

• 600 BC: First Production by Chinese
  –Gas burned to evaporate brine for salt

• 1291 AD: Marco Polo’s Journey
  –Caspian oil produced for medicine, lamps
  –Brought back sample of oil from Sumatra

Harrison and Testa, 2003, Petroleum and the Environment
Clark, OGJ 14 Aug 06 p. 15
THE WORLD IN 2030

*ExxonMobil Study of Energy Demand

- 50% Increase in Energy Demand in 25 yrs
  - 205 to 335 mmboed
  - 80% of increase in developing nations

- 33% Increase in Population
  - 6 to 8 billion people
  - No growth in Europe, Japan, S Korea, Oz
  - N Amer increase less than 33%

- Oil & Gas: total world supply
  - 3.2 tbo Conventional
    - 1 tbo produced, 2 tbo remaining
      - Only N Amer produced > 50% of reserves
  - Non-Conventional: additional 1 tbo

cac: OGJ, 9 Jan 06, p. 23-25
Figure 1. Oil Prices, 1970-2005

- \( P_1 = \$85/\text{Bbl} \)
- \( P_{10} = \$60/\text{Bbl} \)
- Mean = \$34/\text{Bbl} \)
- \( P_{50} = \$30/\text{Bbl} \)
- \( P_{90} = \$12/\text{Bbl} \)
- \( P_{99} = \$9/\text{Bbl} \)

Inflation Adjusted Dollars per Barrel
(Adjusted by Consumer Price Index)

Nominal Dollars per Barrel

Source: EIA

Rose, AAPG Explorer, Oct 2005, p. 3
Exploration Activity

• Declined Worldwide over last 20 yrs
  – 1 bbl discovered for every 4 bbls consumed
    (Halbouty, Explorer 8.04 p. 36)
  – More oil consumed than discovered every year since 1985
    (Wells, OGJ 2/21/05 p. 21)
Global Discoveries Decreasing
Global Production Increasing

Huge Resource yet to be Developed
Annual Production
Replacement ~ 50%

Billion BOE per year

Source: Laherrere, 2003; Longwell, 2002; USGS

(Heavy oil includes bitumen & assumes primary and secondary recovery)
Oil Produced and Remaining

- 952 bbo produced thru 2004
- Represents 32% of total reserves
- remaining recoverable (outside US)
  - 859 bbo remaining discovered
  - 649 bbo undiscovered
  - 612 bbo reserve growth (existing fields)

cac 2005; McCabe, OGJ, 25 Apr 05 p. 32-33
Oil Discoveries and Reserves

(Brian Maxted quoted by Shirley, AAPG Explorer, 8.04 p. 8-9)

• Ultimate resource base 2.5 tbo
  – 1.9 tbo already discovered
  – 0.6 tbo remaining to be found
  – 90% will be found outside of N America

• Discovery rate peaked in 1960s
  – 1990s discoveries 75% gas
  – Only 1/3rd of total found in 1980s
  – Strat traps increasingly important
    • Now almost 40% of total
    • Up from 10% 50 years ago

cac 2005
Unconventional is ultimate recoverable heavy oil reserves from primary recovery.
Source: U.S. Geological Survey, IEA
Control of Proven Oil Reserves

Oil Reserves Held by New Russian Companies: 6%
Full IOC Access: 6%
NOC Oil Reserves (Equity Access): 11%
NOC Oil Reserves (No Equity Access): 77%

<25% of Oil Accessible
WW Proven Oil Reserves: 1,148 bill. bbl

Source: PFC Energy
## World Oil Balance

<table>
<thead>
<tr>
<th>Quarter</th>
<th>2008</th>
<th>2007</th>
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<tbody>
<tr>
<td></td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;*</td>
<td>1&lt;sup&gt;st&lt;/sup&gt;*</td>
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<tr>
<td>Supply</td>
<td>87.7</td>
<td>87.7</td>
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<tr>
<td>Demand</td>
<td>87.7</td>
<td>86.2</td>
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<tr>
<td>Balance</td>
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</table>

*estimated

OGJ 21 Jan 08 p. 25
### Per Capita and Total World Demand for Oil

<table>
<thead>
<tr>
<th>Country</th>
<th>Bbl/person/yr</th>
<th>World Demand*</th>
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</thead>
<tbody>
<tr>
<td>US</td>
<td>25.6</td>
<td>445</td>
</tr>
<tr>
<td>Italy</td>
<td>12.4</td>
<td>215</td>
</tr>
<tr>
<td>Indonesia</td>
<td>1.9</td>
<td>25</td>
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<tr>
<td>Low Income</td>
<td>1.5</td>
<td>3</td>
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<tr>
<td>World</td>
<td>4.5</td>
<td>78</td>
</tr>
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</table>

*MMbo/day

2002-2003 figures from OGJ 17 Apr 04 (except Indonesia)

- Oil
- Natural Gas
- Nuclear Energy
- Hydroelectricity
- Coal

Cook and Sheath
From Armentrout, 2000, AAPG.org
Future GOM Oil and Gas Production
US Exploration Switches to Gas

Source: Baker Hughes Inc.

Nina M. Rach, OGJ 20.09.04 p. 43
General Industry Trends

• Production rates exceed discovery rates
• Large volume of discovered resource is undeveloped
  – mainly gas & heavy oil in remote or sanction areas
• Discovery rate continues to decline long term
  – Will be perturbations – DW, N.Caspian etc.
• Geography & control of undiscovered reserves
  – Middle East, FSU, NOC > 75%
• New resource discovery & development of discovered resource will be key and challenging
• Understand market & technology drivers

CAC 06, mod from Langtree 05
GLOBAL OIL AND GAS FIELDS

Modified from Armentrout, 2000, AAPG.org
Living & Working Abroad: Concerns

• Culture Shock
• Medical
  – Services & Infrastructure
  – Exposure to Disease
• Security Concerns and Stress
• Family Concerns
  – Living remote from family & friends
  – Schools and Child Care
  – Spouse Work and Activities
  – Access to Consumer Goods
Living & Working Abroad

Advantages

• Exposure to New Culture & Friends
• Exciting Work Environment
• Increased Responsibility
• Travel
• Lifestyle
• Compensation & Benefits
The Petroleum Geoscientist - A Detective

• Predicts where oil and gas occurs by using well data and ‘remote sensing’

• Uses tools to gather data -
  gravity and magnetics rock distribution and properties
  geophysical imaging computer process & visualization

• Uses concepts to develop models:
  structural concepts, petrol systems, etc

• Makes economic analysis and recommends drilling
Geologic Mapping and Sampling

- Gravity
- Magnetics
- Seismic Reflection
- Geologic Mapping

Armentrout 2000, from American Petroleum Institute, 1986
Stratigraphy: Understanding the processes creating sedimentary units

Clastic Sedimentology

Forward Modeling

Sedimentary Modeling

Record missing due to erosion: Must reconstruct history from regional data

MESOZOIC & CENOZOIC

Carbonate Analogues

From Armentrout, 2000, AAPG.org
Structural Geology

Understanding the process of deformation of the subsurface due to external forces

Case Histories: Outcrop and Seismic Modeling: Physical and Computer Stratigraphic Consequences

Seismic

Interpretation

Physical Models

Physical Models as Guides to Interpretation

Oblique Slip Model

3D Kinematic Model Building

From Armentrout, 2000, AAPG.org
Characterizing the type, history and origin of petroleum

Determine Age of Oils

Predict Oil Quality

Source Rock Prediction

Migration Pathways

Inorganic & Organic Sedimentology

From Armentrout, 2000, AAPG.org
Reservoir Characterization focuses on data integration to model reservoir architecture and flow properties.

- Seismic visualization
- Resistivity modeling
- Outcrop studies
- Geostatistics
- Fracture characterization
- Production data inversion
- Reservoir Optimization

From Armentrout, 2000, AAPG.org
Computer Simulation and History Matching

From Armentrout, 2000, AAPG.org
Job Market Expectations
By Employers

**Required Traits**
- Self-motivated
- Computer Literate
- Well Educated
- Team Player
- Excellent Communicator

Modified from Armentrout, 2000, AAPG.org
GEOSCIENCE SKILLS

• Companies differ, but
• All favor a mixture: science, computer, non-tech
• Geology & Geophy
• Fieldwork and mapping experience are important

• Top Technical Skills:
  – Petroleum Geol
  – Geophysics
  – Sedimentology
  – Mapping
  – Strat/Sequence Strat
  – Petroleum Systems
  – Regional Geology
  – Reservoir Geology

Heath, 2002
COMPUTER SKILLS

• PC skills  **Required**
  – Word Processing
  – Spreadsheet
  – Presentation

• Workstation
  – Try to get exposure
  – Interpretation most important: Landmark, Charisma, etc.
NON TECHNICAL SKILLS

- Initiative
- Ethics and Integrity
- ENTHUSIASM
- Adaptability
- Cooperation
- Oral Communication
- Grasp & Summarize

Key Issues

Heath, 2002
PRESENT REALITY: RELEVANT INTERACTIVE RESEARCH

Kaldi, 2004
Career Strategies

• Set Goals –
  – Direction
  – Timing
• Prepare to Compete
  – Stay Versatile
  – Be Patient
• Network
• Keep Growing
  – Find, use a Mentor
  – Develop New Skills

CAC 2005
Professional Societies
Why Join?

• Learn about your future career
• Increase your knowledge with exposure to leaders in science and industry
• Expand interpersonal, organizational, & management skills
• Network – interaction with peers
• Helps you throughout your career
AAPG STUDENT BENEFITS

• Great Publications: Bulletin, Explorer
• Books, Books, Books
  – Publication Pipeline
  – Discounts on AAPG Books
  – $500 Book Gift (3 yr cycle)
• Grants-in-Aid for Grad Study
• Weeks Grants (SC and student)
WEEKS GRANT
2003 awards

$500/yr for Chapter

$500/yr for Student
STUDENT CHAPTER ACTIVITIES

• Distinguished Lecturers from AAPG and Industry
• Short Courses and Seminars
• Field Trips
• Exhibits at Conferences
• Other Events: on Campus & off Campus

Univ Sriwijaya geophysical survey in Sumatra, 21 Feb 2004
Why stay an AAPG Member through your career?
Professional Standing & Recognition

- Code of ethics
- Membership limited to trained & experienced professionals
- Professional certification available
- Networking opportunities
- Present your work at meetings & conventions
- Regional & international contacts & events
- Honors & Awards