FORT VALLEY STATE UNIVERSITY
A State and Land-Grant Institution • University System of Georgia

What do pre-service teachers need to know to be successful teaching Earth science

Importance of early uptake of Earth literacy?

Dr. Aditya Kar
Associate Professor of Geology
Cooperative Developmental Energy Program &
Department of Chemistry / Geology
Fort Valley State University, Fort Valley, GA

The geosciences have an important role to play in addressing whether humans can live sustainably on Earth. From water to energy, from climate change to natural hazards, geoscience is central to solving a wide range of problems.

David Gosselin, *University of Nebraska - Lincoln*
Cathy Manduca, *Carleton College*
Timothy J. Bralower, *The Pennsylvania State University*
David Mogk, *Montana State University*

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FVSU
Extension
478-825-6296


JUNIOR SCHOLAR
2016

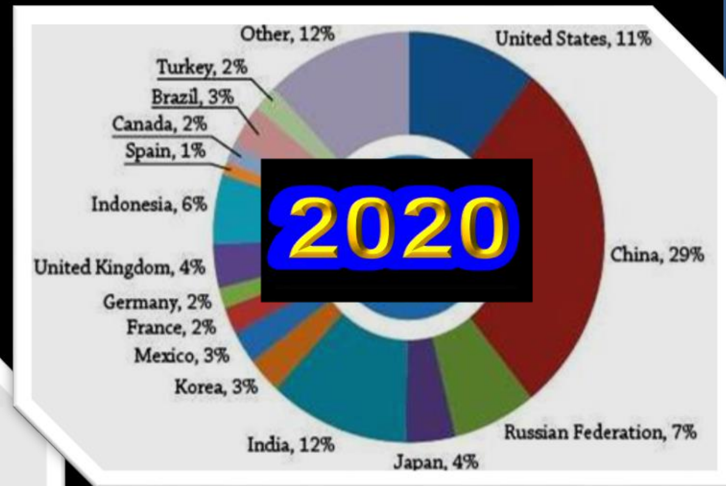

2016


JUNIOR SCHOLAR
2016

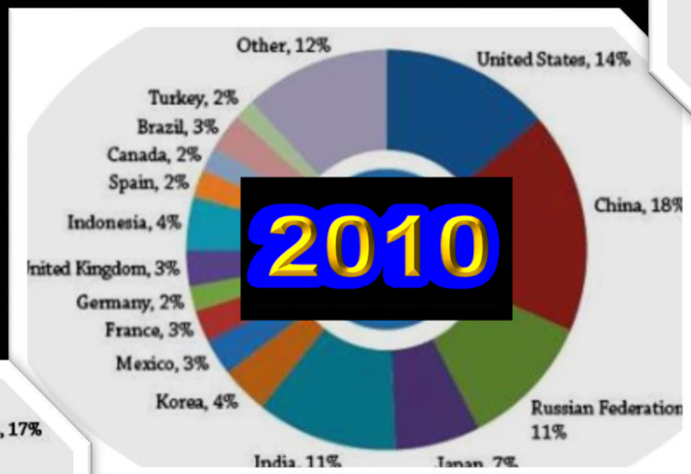
Share of 25-34 year-olds with a tertiary degree across OECD and G20 countries (2000, 2010, 2020)

China: 17% - 18% - 29%
India: 10% - 11% - 12%
Indonesia: 3% - 4% - 6%
Turkey and Brazil show a small increment while Canada and Mexico shows no change.

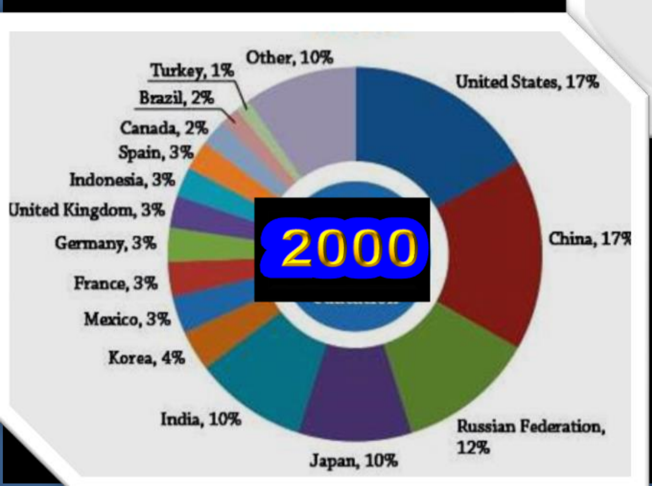
~200 million 58% 124%
40% or 80 mil
From China & India



~130 million 42%
66 mil OCED
64 mil non-OCED

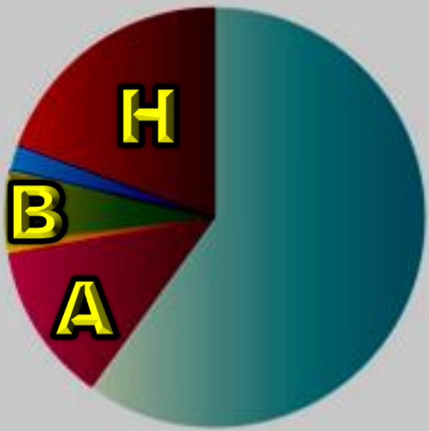


~ 90 million
50 mil OCED
40 mil non-OCED



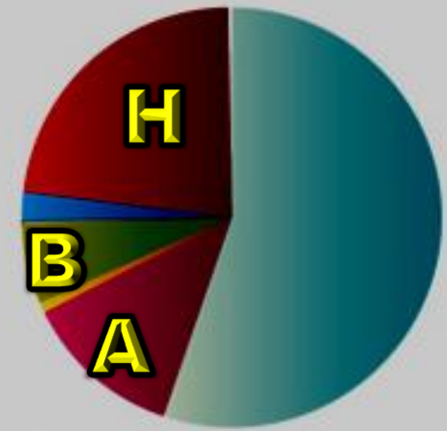
US: 17% - 14% - 11%
Russia: 12% - 11% - 7%
Japan: 10% - 7% - 4%
ALL western European countries & Korea show decline except UK which projects a growth

2020



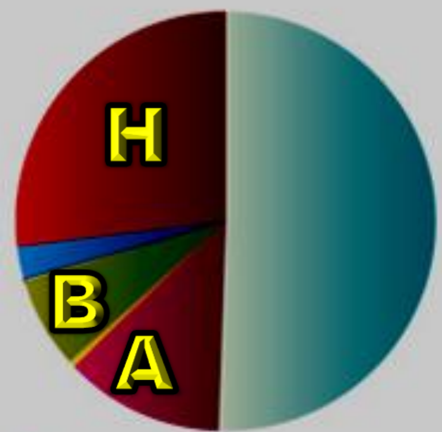
White	60.1%
Black	12.3%
Native American/Alaskan Native	0.8%
Asian	5.4%
Hawaiian /Pacific Islander	0.2%
Other	1.9%
Latino	19.4%

2030



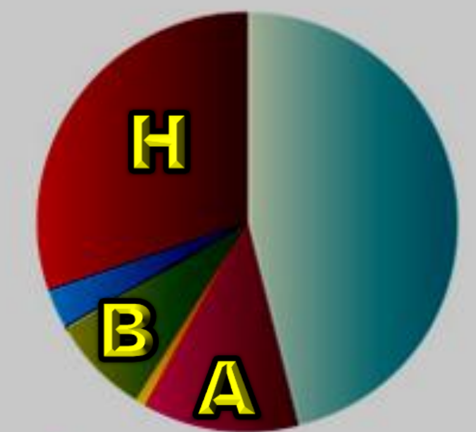
White	55.5%
Black	12.2%
Native American/Alaskan Native	0.8%
Asian	6.2%
Hawaiian /Pacific Islander	0.2%
Other	2.2%
Latino	

2040



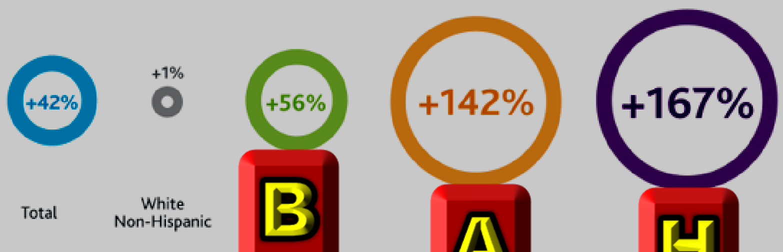
White	50.8%
Black	12.0%
Native American/Alaskan Native	0.8%
Asian	6.9%
Hawaiian /Pacific Islander	0.2%
Other	2.6%
Latino	26.7%

2050



White	46.3%
Black	11.8%
Native American/Alaskan Native	0.8%
Asian	7.6%
Hawaiian /Pacific Islander	0.2%
Other	3.0%
Latino	30.2%

Projected U.S. Population Growth From 2010 to 2050



*Excludes American Indian, Alaska Native, Hawaiian & Other Pacific Islander
Source: U.S. Census Bureau Population Projections

CURRENT # OF ENGINEERS PRODUCED		US 74,399	UK 23000
India	184000	2x US	8x UK
China	460000	6x US	20x UK

	ALL	US	White	API	Black	Hispanic[a]	NATIVE	OTHERS	TEMP	
S&E	32%	32%	30%	47%	30%	31%	32%	31%	39%	
Non-S&E	68%	68%	70%	53%	70%	69%	68%	69%	61%	
Earth sciences	5%	98%	84%	2%	2%	4%	1%	5%	2%	100%
Mathematics & Stats		95%	69%	9%	6%	6%	0.5%	5%	5%	100%
Chemistry		96%	64%	12%	8%	7%	0.7%	4%	4%	100%
Physics		95%	74%	6%	4%	5%	0.6%	7%	5%	100%
Engineering	95%	93%	65%	12%	5%	7%	0.5%	4%	7%	100%

5% of degrees went to earth sciences wrt engineering

95% of degrees went to engineering wrt earth sci

	White	Asian	Black	Hisp
	28,247	834	539	1,335
Earth Science	91%	3%	2%	4%
	1	3	4	2

	White	Asian	Black	Hisp
	430,778	79,428	31,051	48,269
ENGINEERS	73%	13%	5%	8%
	1	2	4	3

FVSU & CONSORTIUM		
18	3%	2001–10
32	6%	1998–2014

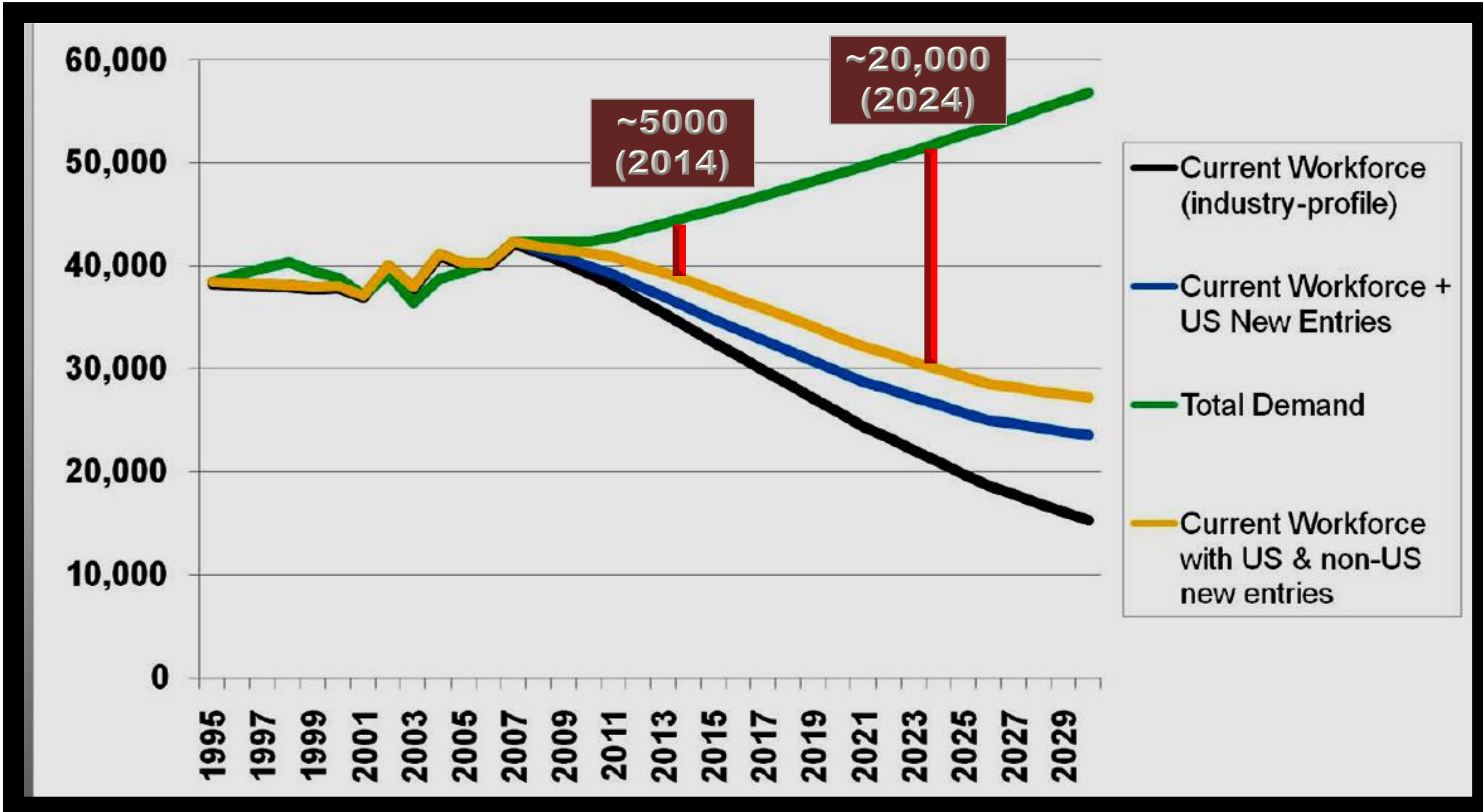
FVSU & CONSORTIUM		
86	0.3%	1998–2014

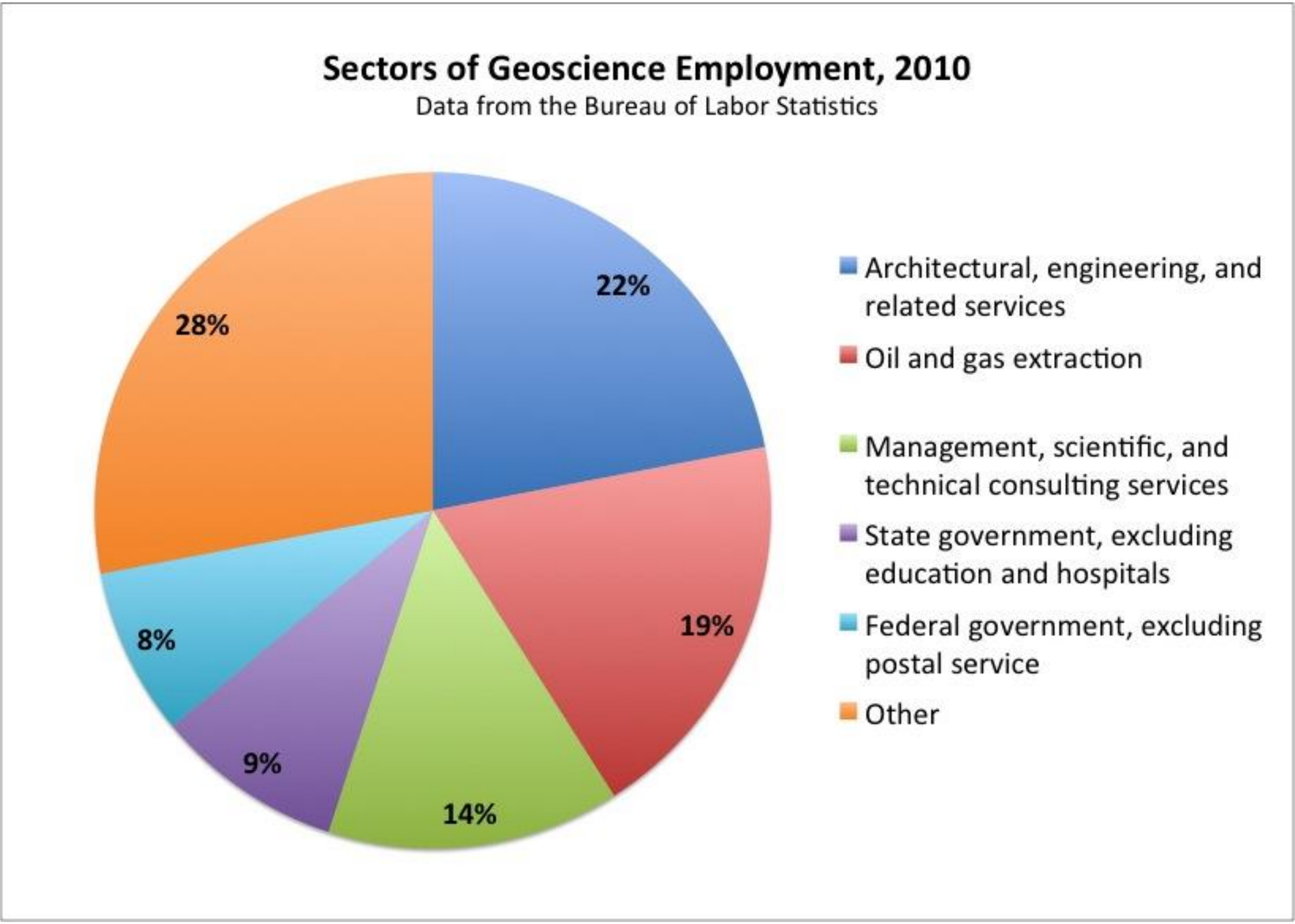
Geoscience Workforce

Projected Supply and Demand of Geoscientists in the Petroleum Industry

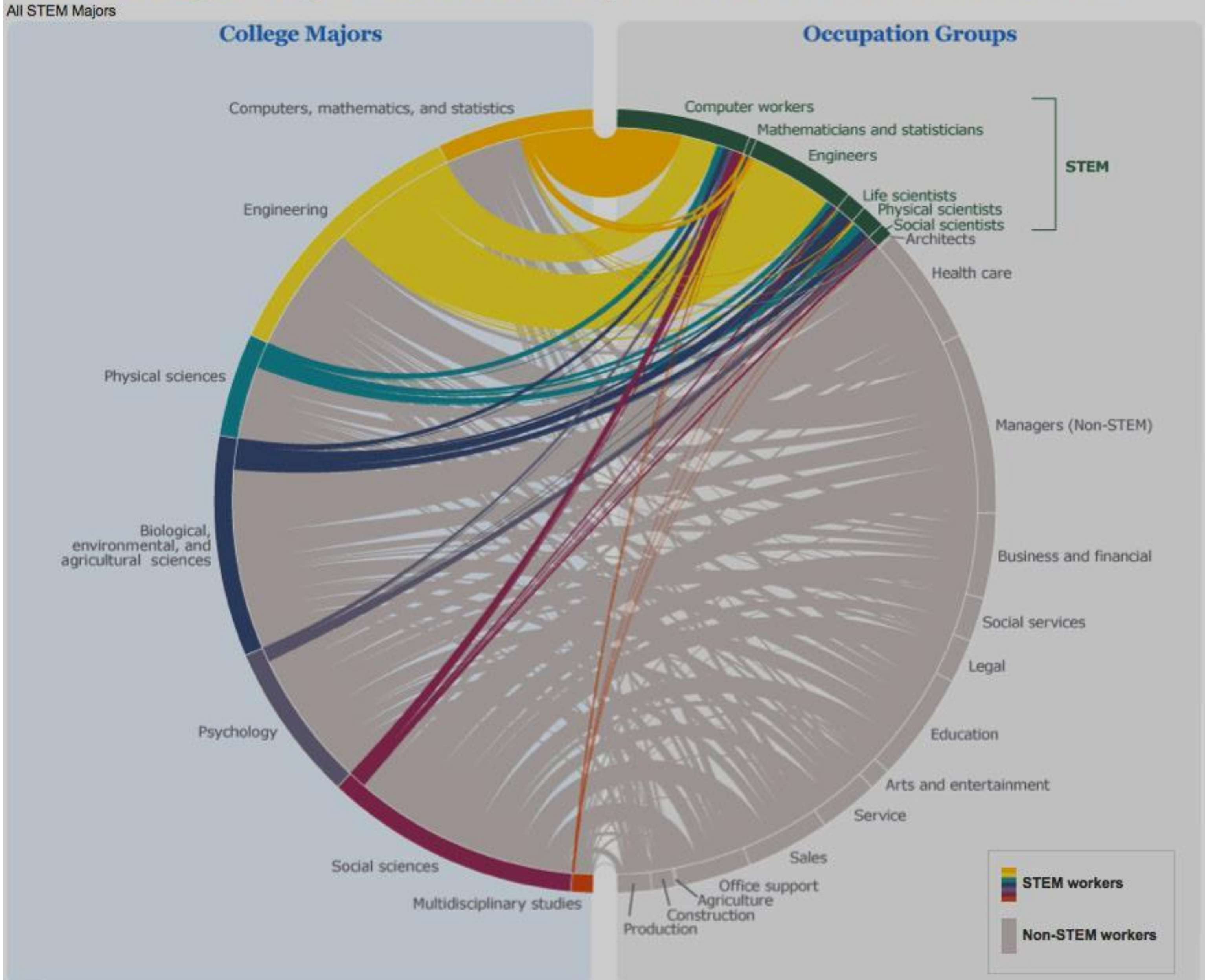
Source: AGI Geoscience Workforce Program

GEOSCIENCE WORKFORCE PROGRAM




Sectors of Geoscience Employment, 2010
Data from the Bureau of Labor Statistics
22%
19%
14%
9%
8%
28%
Architectural, engineering, and related services
Oil and gas extraction
Management, scientific, and technical consulting services
State government, excluding education and hospitals
Federal government, excluding postal service
Other

College Majors and Occupations: A focus on STEM



Based on 2012 data.

Data & image from US Census Bureau: http://www.census.gov/dataviz/visualizations/stem/stem-html/

COOPERATIVE DEVELOPMENTAL ENERGY PROGRAM (CDEP)

is hosted by the Fort Valley State University (FVSU), an HBCU and a part of the 29 University System of Georgia institution and located in middle Georgia, 100 miles south of Atlanta, GA.

It was founded with the vision to alleviate the deficit of females and minorities in the energy industry.

At the core of CDEP lies its 3+2 dual degree academic excellence program

Fort Valley State University
A State and Land-Grant Institution • University System of Georgia

A Presentation Prepared by:
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7 UNIVERSITIES

7 STEM PROGRAMS	1 Fort Valley State Univ	2 UNLV	3 GT	4 UTPA	5 University of Arkansas	6 The University of Texas at Austin	7 PennState
1 MATH	B.S. Degree Math						
2 CHEM	B.S. Degree Chem						
3 BIO	B.S. Degree Bio						
4 GEO		B.S.Degree Geology			B.S.Degree Geology	B.S. Degree Geology / Geophysics/ Hydro Geo/ Env Geo	B.S.Degree Geo-sciences
5 P.E.						B.S.Degree Petroleum Engg	B.S.Degree Petroleum Engg
6 ENGG		B.S. Degree Engineering CE, ChE*, CompE, EE, ME	B.S. Degree Engineering CE, ChE*, CompE, EE, ME	B.S. Degree Engineering CE, CompE, EE, ME	B.S. Degree Engineering CE, ChE*, CompE, EE, ME		
7 H.P.		B.S. Degree +Health Physics					

Degrees from FVSU (3 yrs)

Degrees from Partnering Univ (2 yrs)

Note 1: ChE* degree
Can be combined with Chemistry ONLY at FVSU

Note 2: +HP degree:
In addition to Biology, Math & Chemistry tracks can be followed at FVSU

INDEX
- CE = CIVIL
- ChE = CHEMICAL
- CompE = COMPUTER
- EE = ELECTRICAL
- ME = MECHANICAL

RECRUITMENT

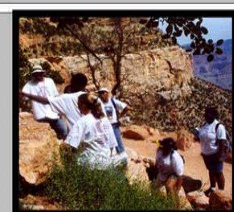
2. Directly from High School (nonMSEA)

RECRUITMENT

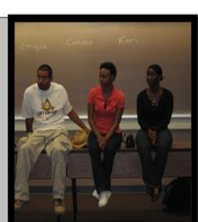
1. Through 9th-12th grade home grown pipeline program (MSEA)

9th Grade
- Recruited across US from Alaska to Georgia
- Fort Valley State
- Penn State
- Georgia Tech
- Washington D.C. (USGS)
- Harper's Ferry, WV
- Geology and Engineering

10th Grade
- University of Nevada, Las Vegas
- Engineering, Math and Geology
- Hoover Dam
- Grand Canyon
- Yucca Mountain



11th Grade
- University of Texas, Austin
- Geosciences
- Field Studies throughout Central Texas
- Devil's Waterhole
- Enchanted Rock



12th Grade
- Fort Valley State
- SAT Prep
- Visit Major Oil Companies in Houston, TX
- BP, Exxon Mobil, Conoco, Marathon, Shell Oil
- Mentoring by peers

CDEP's PRECOLLEGIATE PIPELINE PROGRAM : MATHEMATICS, SCIENCE, ENGINEERING ACADEMY (M-SEA):

- an academic excellence program that recruits 9th graders nationally & 4 summers bring them back to expose the students to subjects like GEOLOGY and ultimately serves as the feeder program to the 3+2 dual degree CDEP Programs.

National Association of Black Geoscientists (NABG)

Student Chapter at the Fort Valley State University

President: James Pippin **Vice President:** Jessica Clark **Secretary:** Maya Kedem
Treasurer: Filmore Thomas **Parliamentarian:** Mercy Browder
Faculty Advisor & Founding Member: Dr. Aditya Kar, Associate Prof of Geo, FVSU

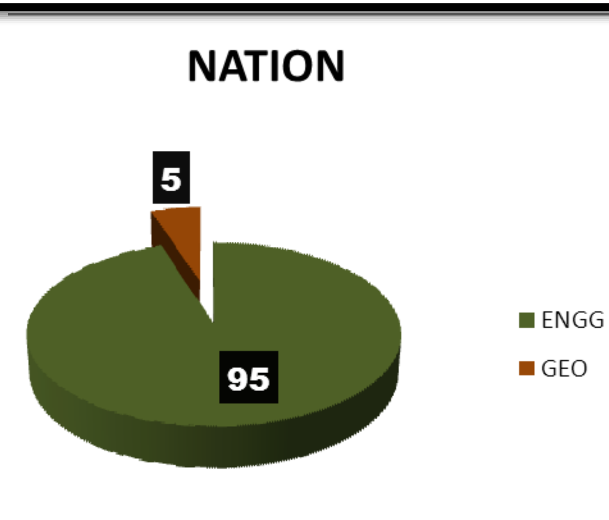
Field, citizenship, and race/ethnicity — 2001-2010

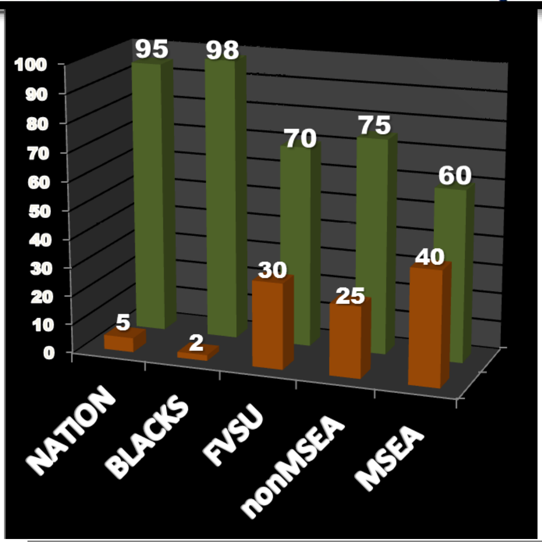
	ALL FIELDS		U S CITIZENS		WHITES		BLACKS		HISPANICS		ASIANS		AM.INDIANS		OTHERS		TEMP. RES.	
Non-S&E	10,041,436	70%	9,771,077	70%	6,929,596	70%	909,238	70%	798,183	70%	494,167	50%	69,087	70%	570,806	70%	270,359	60%
S&E	4,679,652	30%	4,504,846	30%	3,021,530	30%	390,851	30%	366,065	30%	434,674	50%	32,071	30%	259,655	30%	174,806	40%
Earth sciences	33,623	5%	33,024	98%	28,247	84%	539	1.60%	1,335	4%	834	2%	268	0.80%	1,801	5%	599	1.8%
Mathematics	144,847	of degrees went to earth sciences wrt engineering	137,776	95%	99,767	70%	8,230	5.68%	8,201	6%	13,326	9%	655	0.45%	7,597	5%	7,071	4.9%
Astronomy	3,177		3,035	96%	2,316	75%	43	1.35%	192	6%	228	7%	20	0.63%	236	7%	142	4.5%
Chemistry	106,257		102,046	96%	68,278	65%	8,300	7.81%	7,396	7%	12,661	12%	693	0.65%	4,718	4%	4,211	4.0%
Physics	43,494	of degrees went to engineering wrt to earth sciences	41,480	95%	32,208	75%	1,564	3.60%	2,015	5%	2,562	6%	245	0.56%	2,886	7%	2,014	4.6%
Other	5,942		5,552	93%	4,224	70%	346	5.82%	287	5%	348	6%	39	0.66%	308	5%	390	6.6%
Engineering	665,848	95%	621,743	93%	430,778	65%	31,051	4.66%	48,269	7%	79,428	12%	3,281	0.49%	28,936	4%	44,105	6.6%

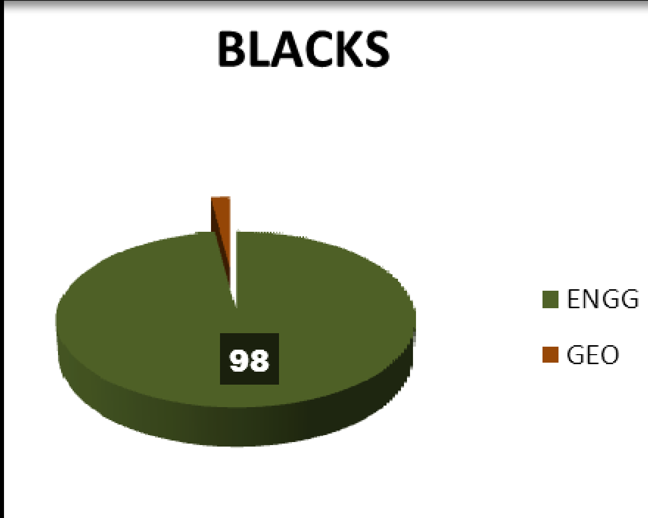
Source: NSF 2013	ENGG	GEO
NATION	95%	5%
BLACKS	98%	2%

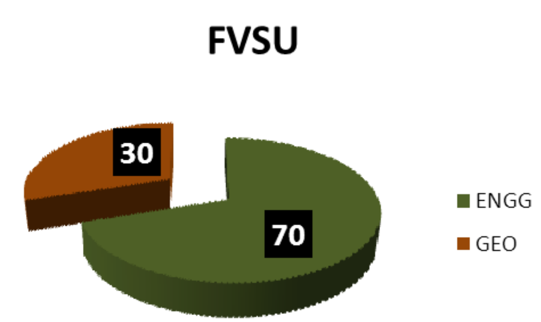
URMs and Traditional VS. Non-traditional subjects

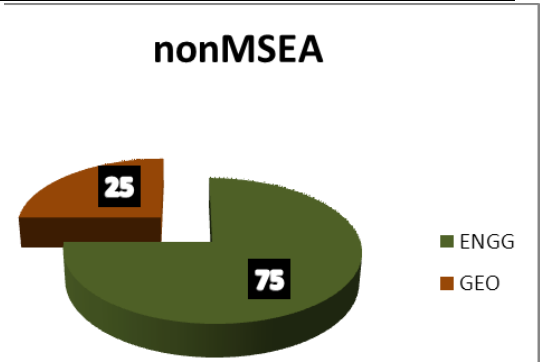
National average for traditional (Engineering) degrees vs. non-traditional (Earth Science) is 95:5;

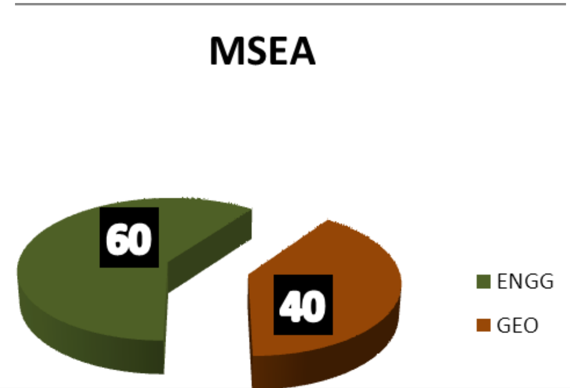




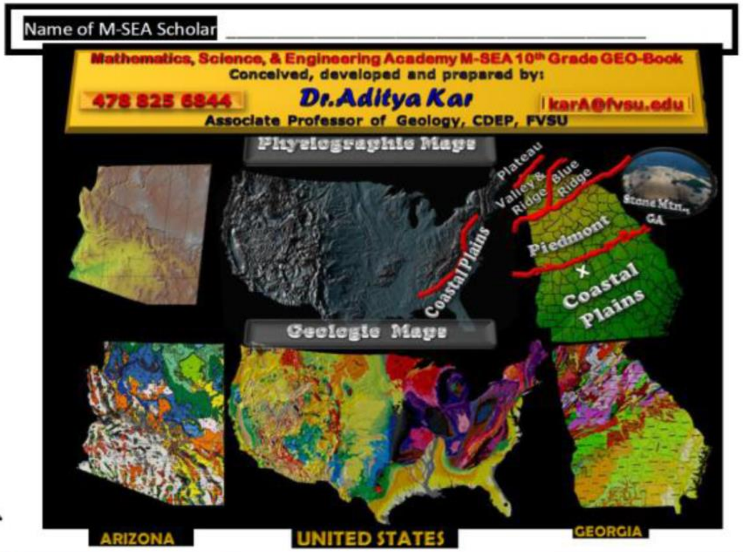


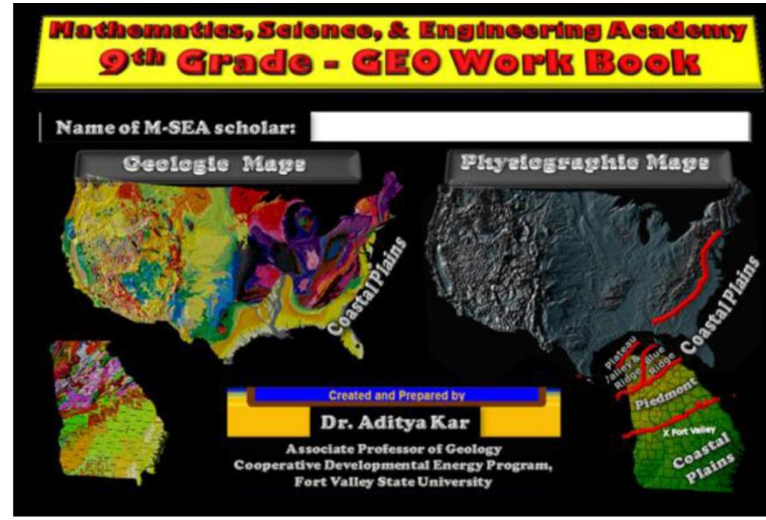


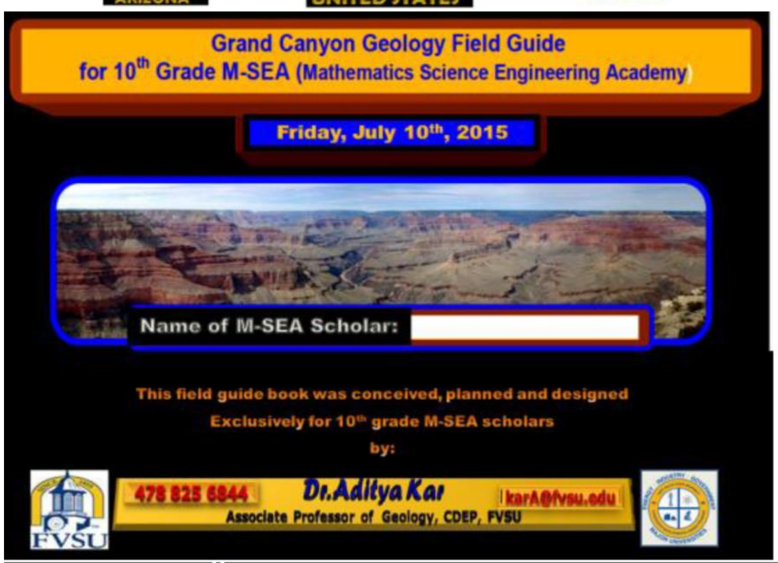




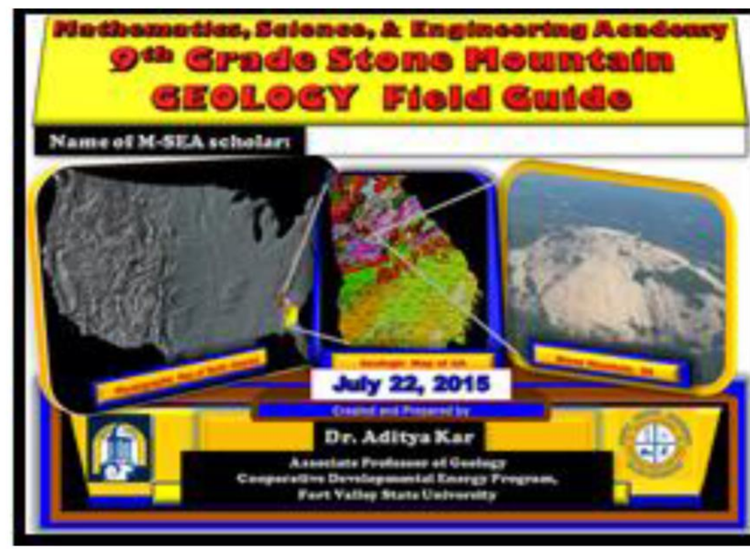
FVSU graduates (Engg & Geo) chose non-traditional degree by 28% more than the National average for Blacks (2%).







10th GRADE ACADEMY



9th GRADE ACADEMY


UT

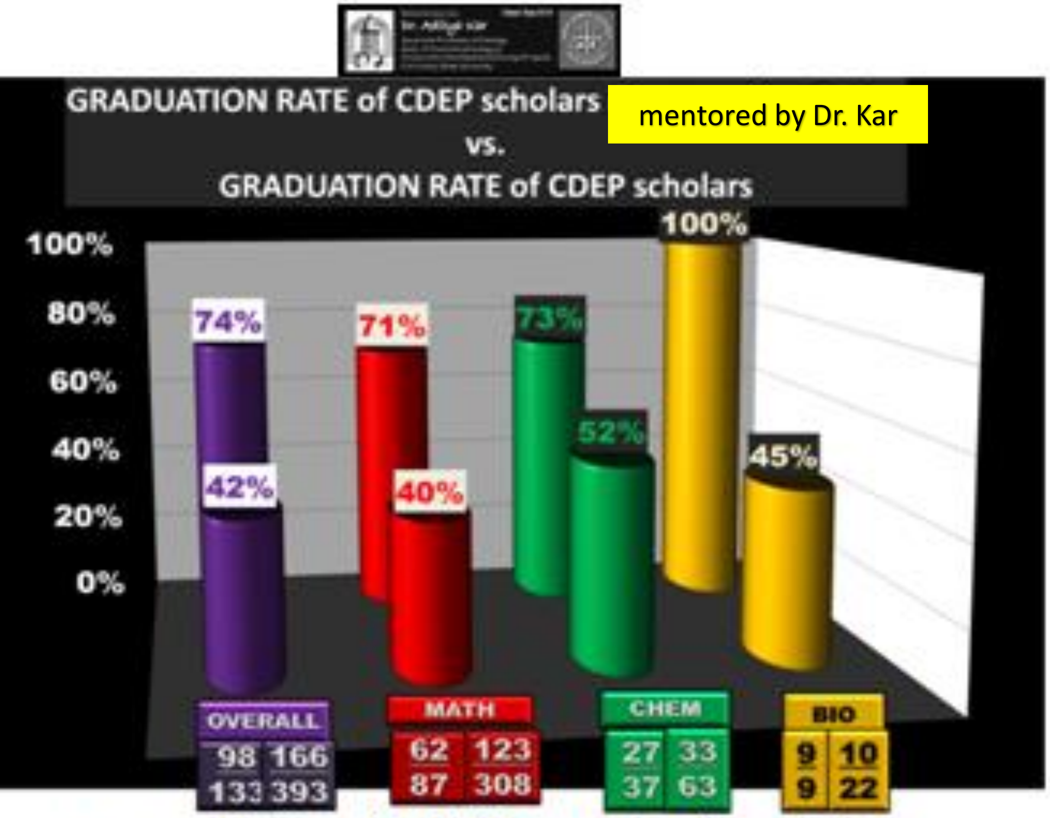


Figure Active role of advisement and mentoring in student's on-time graduation

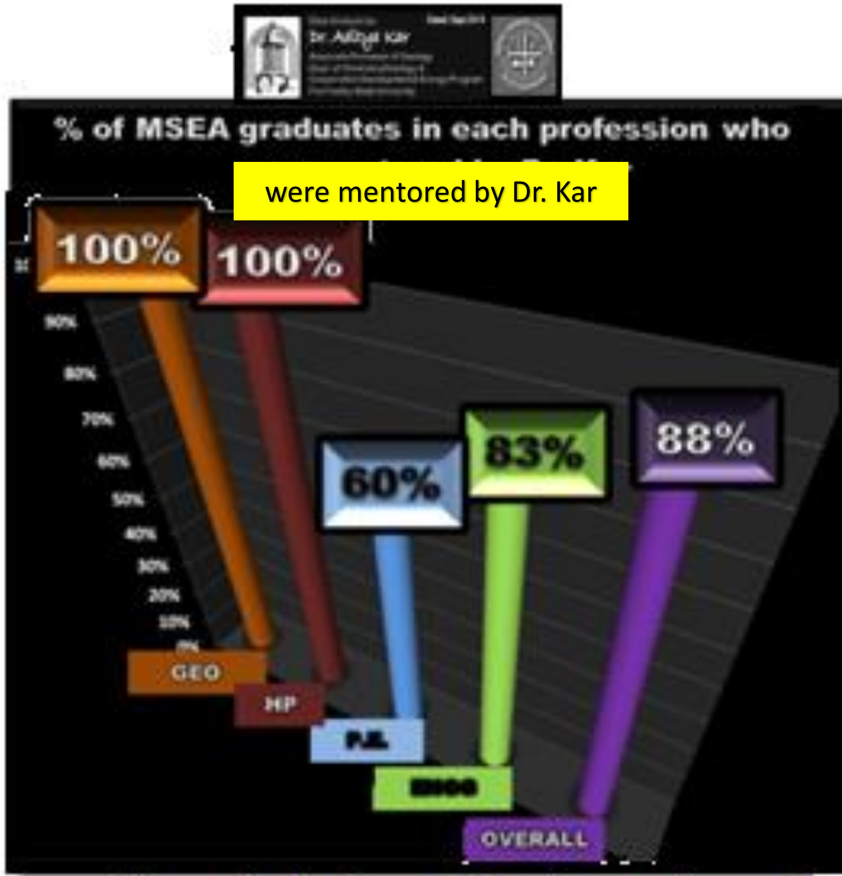


Figure Role of mentoring in retention and graduation with the 2nd degree.

FVSU's PRECOLLEGIATE PIPELINE PROGRAM:

MATHEMATICS, SCIENCE, ENGINEERING ACADEMY (M-SEA):

M-SEA, like CDEP is an academic excellence program that targets and recruits nationally minority and female students at the 9th grade year.

Provided the students maintain high academic standards during school year, they are then invited back over the next 4 years (9^{th}–12^{th} grade) for weeklong summer experiences at FVSU and its partnered universities.

9^{th} Grade

- Recruited across US from Alaska to Georgia
- Fort Valley State
- Penn State
- Georgia Tech
- Washington D.C. (USGS)
- Harper's Ferry, WV
- Geology and Engineering

10^{th} Grade

- University of Nevada, Las Vegas
- Engineering, Math and Geology
- Hoover Dam
- Grand Canyon
- Yucca Mountain

11^{th} Grade

- University of Texas, Austin
- Geosciences
- Field Studies throughout Central Texas
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12^{th} Grade

- Fort Valley State
- SAT Prep
- Visit Major Oil Companies in Houston, TX
- BP, Exxon Mobil, Conoco, Marathon, Shell Oil
- Mentoring by peers

Fort Valley State University

A Presentation Prepared by:

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Associate Professor of Geology

Dept. of Chemistry/Geology

Fort Valley State University

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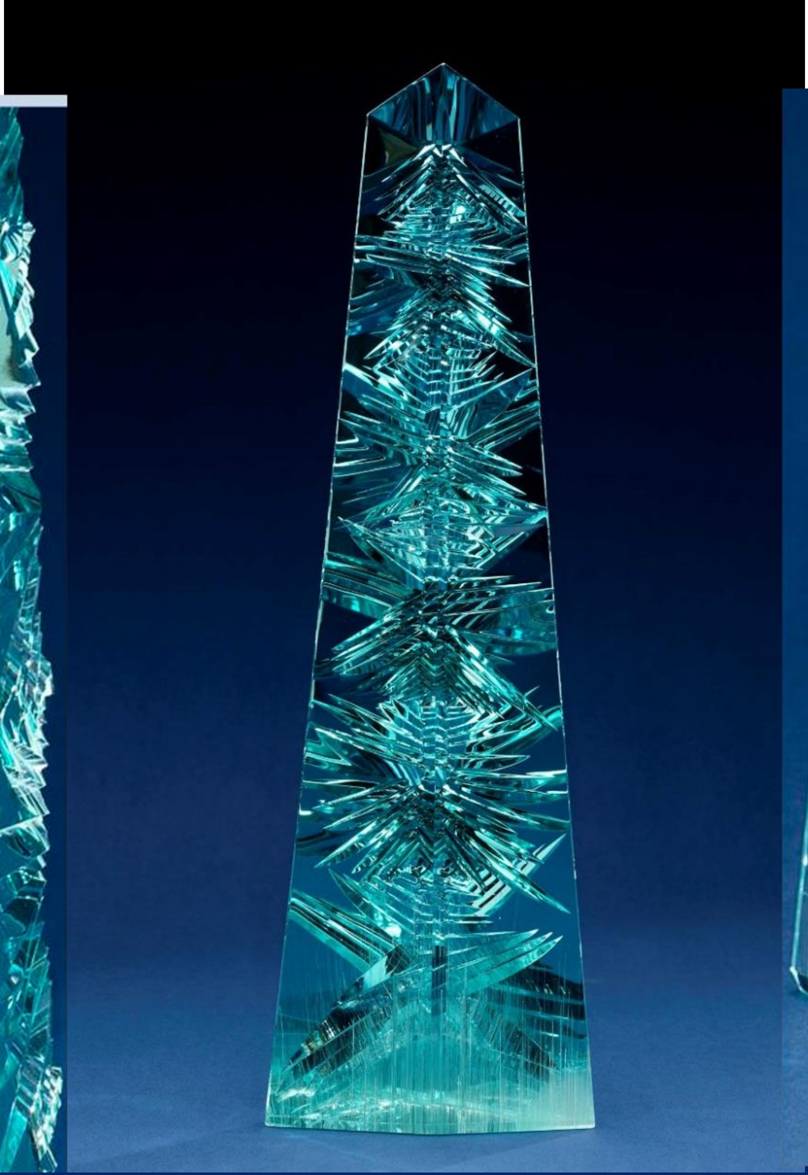
MSEA's STEM-ulating journey starts at The National Gem Collection

Smithsonian

HOPE DIAMOND

The necklace chain contains 45 white diamonds.
Weight: 45.52 carats


Escalator
EXHIBITS
RESTROOMS
IMAX
Information
PERRY



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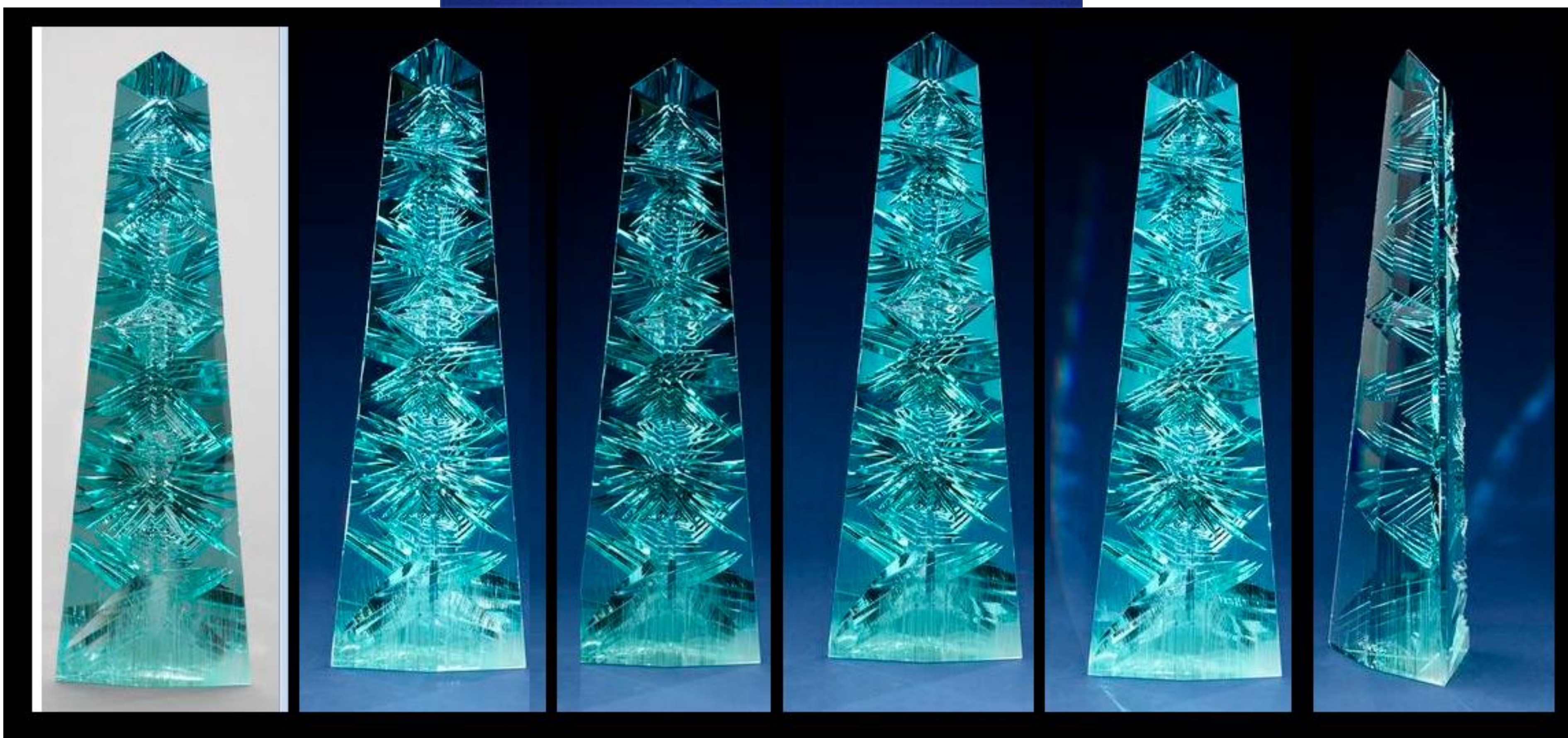


VSU



GRAND CANYON
NATIONAL PARK
NATIONAL PARK SERVICE

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JUNIOR SCHOLAR
2015


JUNIOR SCHOLAR
2016
CDEP
MATHEMATICS
SCIENCE &
ENGINEERING
ACADEMY


E
D
C
B
A
Na-Feldspar
Biotite-Mica
Muscovite-Mica
HIGH
TEMPERATURE
LOW
Wt%
SiO2
Small (Volcanic)
Large (Plutonic)
Depth = Texture
Komatite
Basalt
Andesite
Rhyolite
Green
light
40%
50%
60%
70%
Ultramatic (Um)
Mafic (M)
Intermediate (Int)
Felsic (F)
GROUP 2

FORT VALLEY STATE UNIVERSITY

A Presentation Prepared by:

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M-SEA GEOLOGY CURRICULAR MAP – Created by Dr. A. Kar, Ass. Prof, FVSU

9TH	10TH	11TH	12TH

WHAT IS GEOLOGY?	WHAT DOES GEOSCIENTIST DO?	HOW MUCH DO GEOSCIENTISTS EARN? ;-)

PLANETARY GEOLOGY	GLOBAL CLIMATE CHANGE

- MATTER
- ATOMS
- ELEMENTS
- COMPOUNDS
- MINERALS
- ROCK CYCLE & PLATE TECTONICS
- IGNEOUS ROCKS
- GEO TIME SCALE & AGE DATING

MATTER ATOMS ELEMENTS COMPOUNDS MINERALS
ROCK CYCLE IG ROCKS PLATE TEC GEO TIME & AGE DATING

HAND SAMPLE ANALYSIS OF MINERALS

HAND SAMPLE ANALYSIS OF IG ROCKS

STONE MOUNTAIN FIELD TRIP

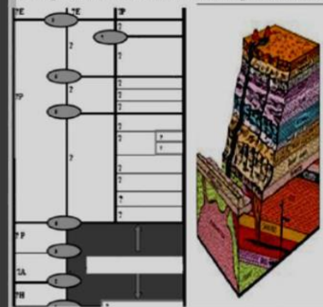
EVOLUTION GAME

STOP1. In front of Bright Angel Lodge

1. In a topographic map what are the lines called? ______
2. What is a contour line? ______
3. When contour lines are very closely spaced, the area represents
   a. A hill
   b. A valley
   c. A flat land
   d. None of the above
4. If you walk following a contour line, would you be
   a. Going up?
   b. Going down?
   c. Neither
   d. Both
5. When contour lines are spread out, the area represents :
   a. A hill
   b. A valley
   c. A flat land
   d. None of the above
6. Inner gorge is very steep as compared to the Outer gorge. Shade the Inner Gorge on the topographic map.

STOP1. In front of Bright Angel Lodge

GEOLOGY of the GRAND CANYON: ROCK LAYERS
(Complete and translate the following *mnemonic* sentence into the rock layers)



Era?	Name of the Strata	Age of the Strata (in million years)
	K	
	T	
	C	
	H	
	S	
	R	
	M	
	B	
	T	
The Great Unconformity-		
Late Precambrian Rocks	Chuar Group	
	Sixtymile Formation	
	Kwagunt Formation	
	Galeros Formation	
	Nankoweap Formation	
	Unkar Group	
	Cardenas Lavas or Basalts	
	Dox Sandstone	
	Shinumo Quartzite	
	Hakatai Shale	
	Bass Formation	
The- Pre-Cambrian Unconformity---		
Early PC Rocks	Vishnu Schist, Rama Schist, Brahma Schist and Zoroaster Granite	

STOP1. In front of Bright Angel Lodge

Sediments

Are created by the process of ______. There are 2 types:
1. ______ Examples ______
2. ______ Examples ______

Transported by process of ______. Agents of this process are:1.______ 2.______ and 3.______.

Sediments → Sedimentary Rocks

What are the steps involved?
1. ______ (why does it happen)?
2. ______ (how does it happen)?

Together these 2 processes are called ______ (rock formation).

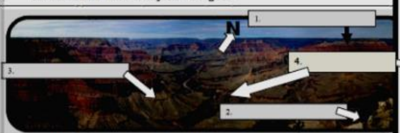
Concept developed by Dr. Aditya Kar, Associate Professor of Geology, Fort Valley State Univ. Summer 2013.

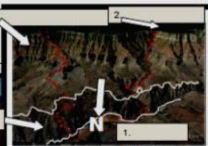
SEDIMENTARY ROCKS (8x8GRID)

							1
							2. BROAD CATEGORY& how are the rocks identified?
							3. SUB-CATEGORY
							4. DRAW
							5. ROCK NAMES
							6. ENERGY
							7. ENVIRON-MENT OF FM
1	2	3	4	5	6	7	8. MINERALS PRESENT

STOP2. At top of Bright Angel Trail head

Question 2.1: Fill in the following GC diagrams with appropriate names for the "Rims" and "Canyons / Gorges."





In the above diagram the Inner Canyon has been outlined by Dr. Kar in white. Two most popular trails are marked in red. On Left of the diagram is the South Kaibab Trail whereas on the right hand side of the diagram is the trail we are about to embark on. Which trail are we going to hike on ? ______

To answer the questions 2.2-2.5, use the last page of this field guide.

Question 2.2: When you will be climbing back up after lunch, is it recommended that you TALK while you WALK? Y or N? Whyy or why not?______

Question 2.3: Not only running is NOT ALLOWED at any time during this hike, during steep climb "baby-sized" steps are recommended. WHY? ______

Question 2.4: Which Canyon / Gorge is a desert? ______ .

Question 2.5: Avg. July Temperature of this part of Grand Canyon is ______ ; in comparison the temperature of the ______ Rim (the rim we are standing on) is______..

STOP3. First Arch on the Bright Angel Trail

Just as you approach the first arch on the trail look at the rock on the wall.

Question 3.1: What kind of rock is this? What kind of environment did this rock form at?
Answer: ______

Question 3.2: Do you see any difference between the different layers within the rock?
Answer: ______

Question 3.3: What does this obvious difference of rocks within the same layer suggest?
Answer: ______

Question 3.4: There are some inclusions in the rock. What minerals are the inclusions made of? What kind of paleo-environment does it indicate?
Answer: ______

Question 3.5: How old is this layer? ______

Question 3.6: What is the approximate elevation here?______

In Summary (*3.1-3.6*), the top layer of GC which is at ______ feet at the present time, ______ million years ago was at the bottom of a ______ ocean that existed at this place.

STOP4. Inside the First Arch

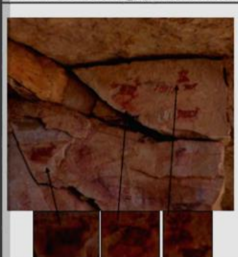
Question 4.1: In the box below, draw a diagram of the wall of the arch (from roof to the floor) pointing out the differences you just noticed in Stop 3.

1. Label your diagram
2. Provide horizontal and vertical scales

STOP5. Just after coming out of the Arch

Just as you come out of the arch, look up on the wall (to your left); look carefully and you will see some red markings; if you look thoroughly you will be able to make out shapes drawn in red.

Question 5.1: What are these drawings called? Who do you think made these drawings, when and why?



Answer: ______

Question 5.2: Draw some of these what you see in the space below.
List what you see.

STOP10. Second Arch on the Bright Angel Trail

Question 10.1: Just *before* you enter the Second Arch, note the rock. What kind is it?
Answer: ______

Question 10.2: Just as you *exit* from the Second Arch, note the rock. What kind is it?
Answer: ______

Question 10.3: If there is a difference in the rock type, what does it suggest?
Answer: ______

Question 10.4: *Look at the cliff section facing you.* Which rock layer is at your eye-level on the cliff section (you are also standing on this rock layer now)?
Answer: ______

FINAL STOP . LUNCH and REVIEW

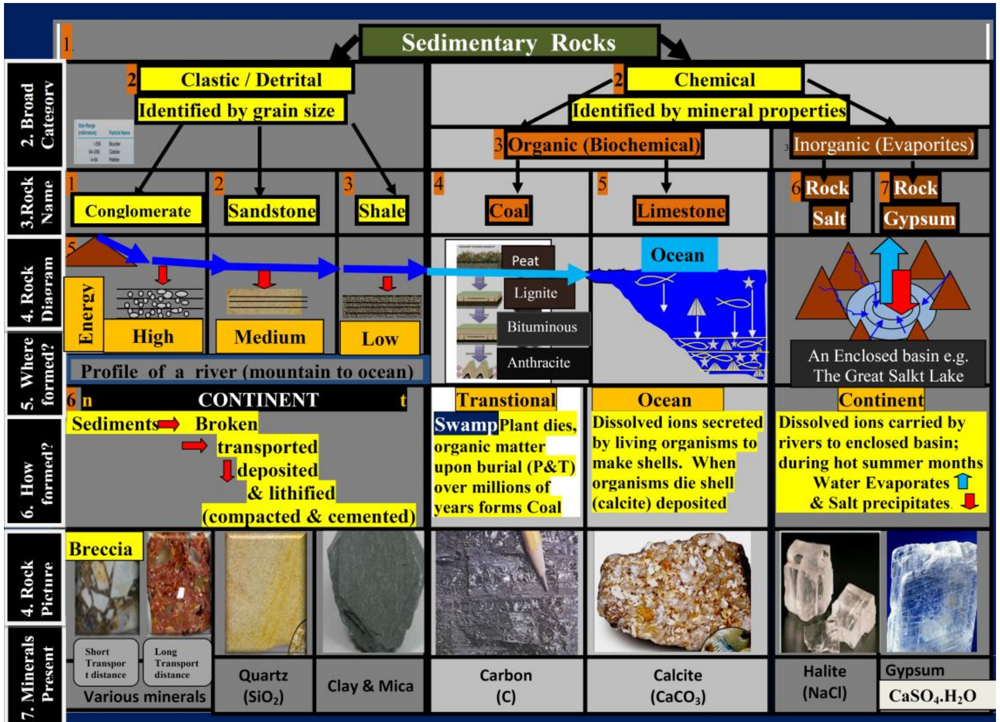
Lunch time Questions: Draw the top 4 stratas of GC below

Stratas	Age	Environment of Deposition

Which rock layers in the Grand Canyon area are cliff formers? Why?
Answer: ______

Lets get back to the Stop 1 Question.
Question: We are standing on the south rim, how far do you think is the north rim? How wide is the Colorado River? Does these two widths match? If not, why?
Answer: ______

After Lunch: Now its time to climb back to the top of the Canyon. Follow the trail and stay with your group. Take time as you climb up, enjoy the beauty of the Great Canyon, and drink plenty of water.



Concept Developed by: **Dr. Aditya Kar**, Associate Professor of Geology, CDEP, Fort Valley State University

Concept developed by Dr. Aditya Kar, Associate Professor of Geology, Fort Valley State Univ. Summer 2013.

SEDIMENTARY ROCKS (8x8GRID)

1

2. BROAD CATEGORY& how are the rocks identified?

3. SUB-CATEGORY

4. DRAW

5. ROCK NAMES

6. ENERGY

7. ENVIRON-MENT OF FM

8. MINERALS PRESENT

1 2 3 4 5 6 7

How long does it take a 9th grader to finish high school, dual STEM degrees & a MS degrees?

A DECADE!!!

2016 - 9th grade

2017 - 10th grade

2018 - 11th grade

2019 - 12th grade

2020 - FVSU 1st year

2021 - FVSU 2nd year

2022 - FVSU 3rd year

(1st BS degree in Chem, Bio or Math)

2023 - Partnering University 1st yr

2024 - Partnering University 2nd yr

(2nd BS degree in Geology)

2025- Master's degree Year 1

2026 - Master's degree Year 2?

TOTAL NUMBER OF STEM DEGREES EARNED BY CDEP DUAL DEGREE GRADUATES

	OVERALL	nonMSEA	MSEA	
GEOSCIENTISTS	36	24	12	33%
PETROLEUM ENGINEERS	6	1	5	83%
HEALTH PHYSICISTS	8	4	4	50%
ENGINEERS	90	70	20	22%
MATHEMATICIANS	145	109	36	25%
CHEMISTS	43	27	16	37%
BIOLOGISTS	11	3	8	72%
TOTAL STEM DUAL DEGREES EARNED	339	238	101	

A Presentation Prepared by:
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Fort Valley State University

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478 825 6844

CURRENT TOTAL GRADUATED Underrepresented Minority (URM) GEOSCIENTISTS

36

19 | 17

nonMSEA

24

13 | 11

MSEA

12

6 | 6

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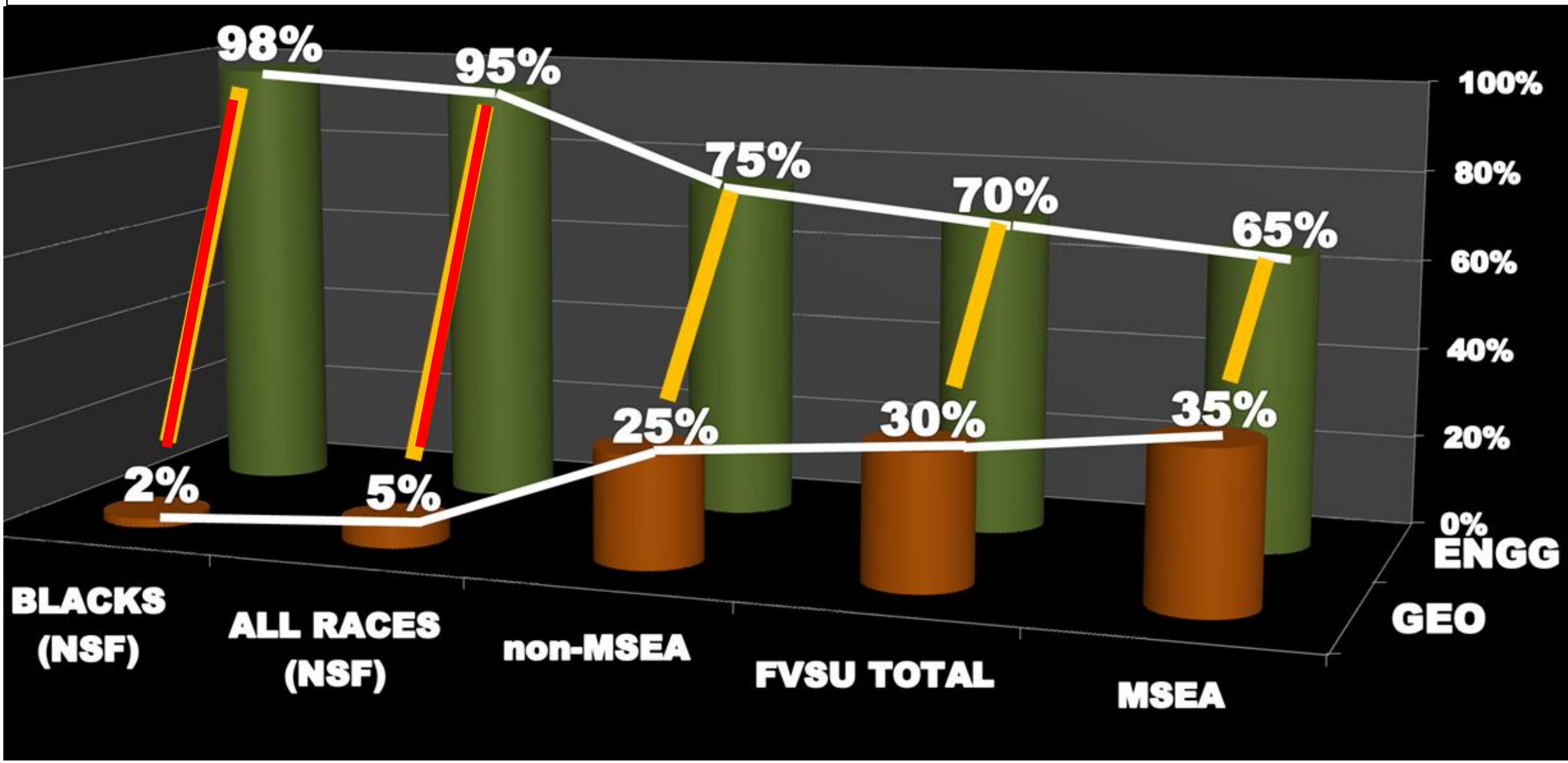
By 2020

TOTAL *ANTICIPATED* GRADUATED URM GEOSCIENTISTS

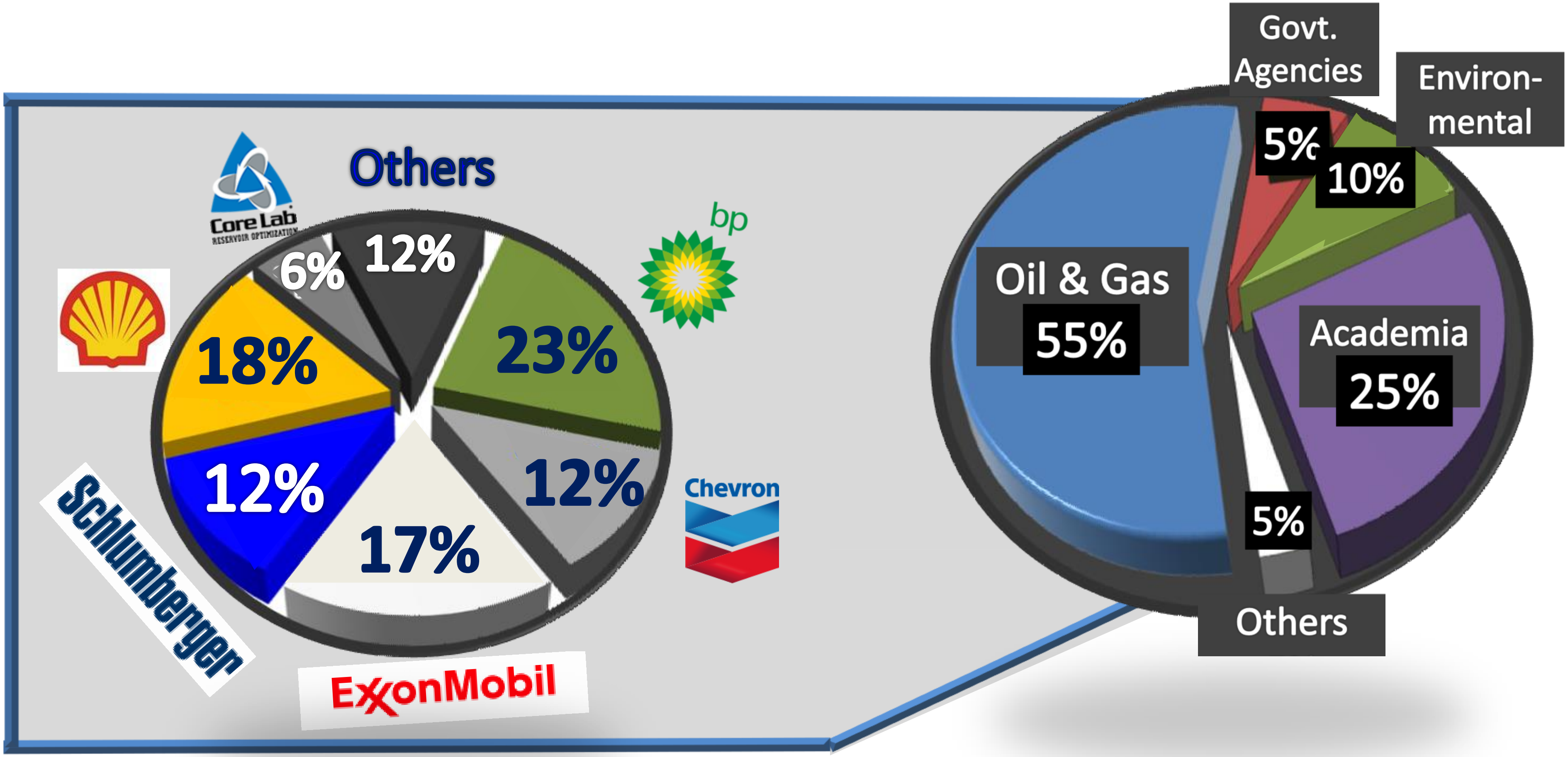
51	
28	23

MSEA	nonMSEA
20	31
9 11	19 12

ENGINEERING DEGREE VS. GEOSCIENCE DEGREE



GRADUATED GEOSCIENTISTS ARE EMPLOYED IN:



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Fort Valley State University

2001-2010: FVSU's contribution to the Nation's URM Geoscientists

As a result of this astoundingly low number,

FVSU partnered with its dual degree universities in geosciences, namely

Univ. of Oklahoma, Univ. of Texas (Austin) & Penn State,

has graduated approximately

3.15%

of all black earth scientists in the nation in the decade spanning 2001-2010.

Fort Valley State University
A State and Land-Grant Institution • University System of Georgia

A Presentation Prepared by:
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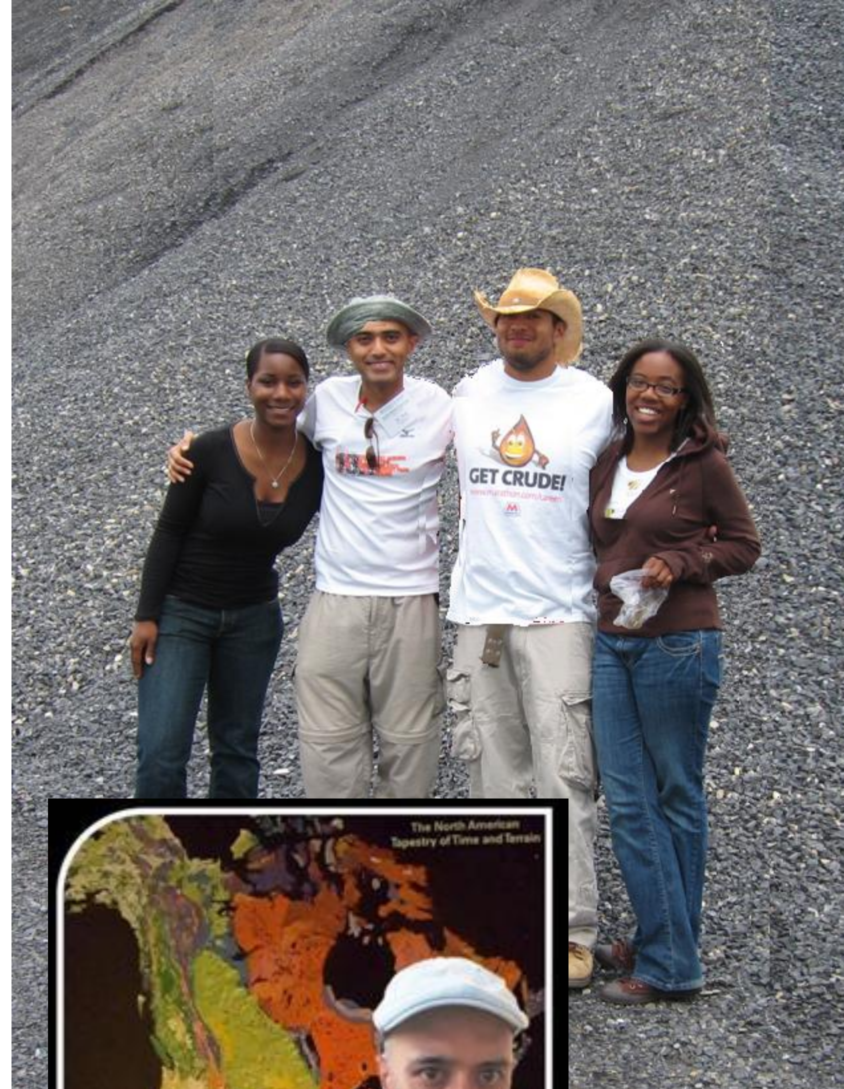
freedom


JACKSON


GET CRUDE!


The North American
Tapestry of Time and Terrain

That’s all folks!

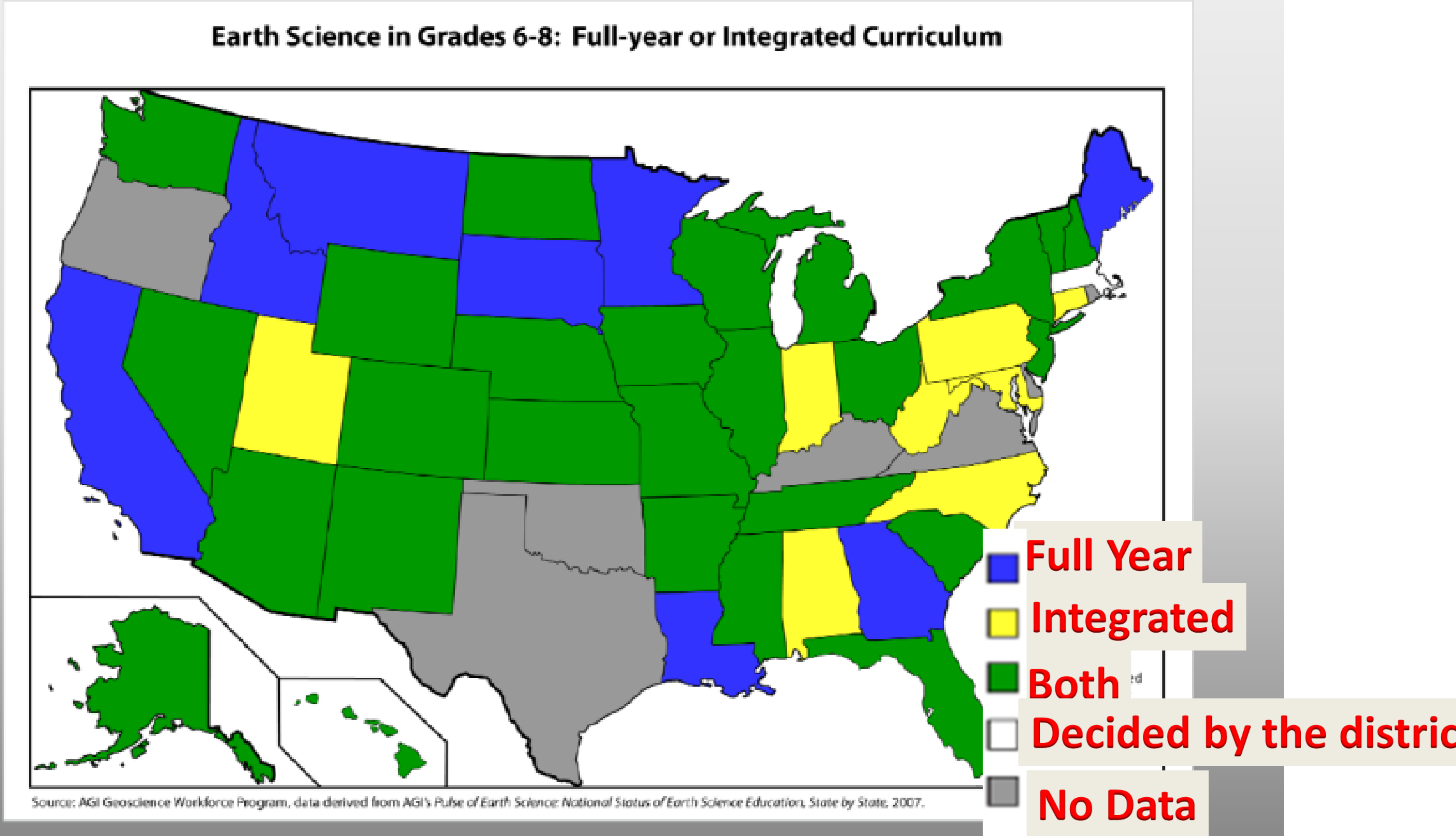
Thank you!

Questions?

What do pre-service teachers need to know to be successful teaching Earth science

1. THE CONTENT
2. THE EXAM: GACE
3. THE STANDARDS: BOTH NATIONAL & STATE

K – 12 Education



Test I Subareas

Subarea	Approx. Percentage of Test
I. Scientific Inquiry, Processes, Technology, and Society	30%
II. Physical Science	70%

Test I Objectives

Subarea I: Scientific Inquiry, Processes, Technology, and Society

Objective 1: Understands the nature of scientific inquiry and processes, including the collection and analysis of data

The beginning Science teacher:

A. Understands methods of scientific inquiry and design
- Identifying problems based on observations
- Forming and testing hypotheses
- Development of theories, models, and laws
- Experimental design, including independent and dependent variables, controls, and sources of error
- Process skills including observing, comparing, inferring, categorizing, generalizing, and concluding

B. Understands the history and nature of scientific knowledge
- Subject to change
- Consistent with evidence
- Based on reproducible evidence
- Unifying concepts and processes, such as systems, models, constancy and change, equilibrium; form and function
- Peer review

C. Understands the major historical developments of science
- Accepted principles and models develop over time
- Major developments in science, such as atomic theory and plate tectonics
- Contributions of major historical figures such as Darwin and Newton

D. Understands the processes involved in scientific data collection and manipulation
- Common units of measurement (metric and English), including unit conversion and prefixes such as milli- and kilo-
- Laboratory notebook practices
- Scientific notation and significant figures in collected data
- Organization, presentation, and communication of data, using appropriate tools
- Basic data and error analysis, including determining mean, accuracy, precision, and sources of error

E. Understands how to interpret and draw conclusions from data presented in tables, graphs, maps, and charts
- Trends in data
- Relationships between variables
- Predictions based on data
- Drawing valid conclusions based on data

F. Understands the procedures for correct preparation, storage, use, and disposal of laboratory materials
- Appropriate and safe use of materials, such as chemicals and lab specimens
- Safe disposal of materials
- Appropriate storage
- Preparations for classroom or field use of materials, such as preparing solutions staining slides

G. Understands how to use standard equipment in the laboratory and the field
- Appropriate and safe use of equipment such as Bunsen burner, glassware, and microscopes
- Appropriate storage of equipment such as pH probes and dissection equipment
- Maintenance and calibration of equipment such as microscopes and balances
- Preparation for classroom or field use, such as prelaboratory setup, classroom demonstrations, and field research

H. Understands safety and emergency procedures in the laboratory
- Location and use of standard safety equipment such as eyewash stations and showers
- Laboratory safety rules for students
- Appropriate apparel and conduct in the laboratory
- Emergency procedures for events such as fires, chemical spills, and injuries

Objective 2: Understands the relationship of science and technology to society and the environment

The beginning Science teacher:

A. Understands that science and technology impact the environment and society
- Acid rain
- Air and water pollution
- Greenhouse gases
- Ozone layer depletion
- Waste disposal and recycling
- Green chemistry
- Irrigation
- Reservoirs and levees

Subarea II: Earth and Space Science

Objective 1: Understands geology, including Earth's structure, rocks, minerals, plate tectonics, and historical geology

The beginning Science teacher:

A. Understands the types and basic characteristics of rocks and minerals and their formation processes
- The rock cycle
- Characteristics of sedimentary, igneous, and metamorphic rocks and their formation processes
- Characteristics of minerals and their formation processes

B. Understands the processes involved in erosion, weathering, and sedimentation of Earth's surface materials
- Erosion and sedimentation
- Chemical and physical weathering
- Characteristics of soil
- Porosity and permeability

C. Understands Earth's basic structure and internal processes
- Earth's layers, such as the crust, mantle, and core
- Shape and size of Earth
- Geographical features
- Earth's magnetic field

D. Understands plate tectonic theory
- Folding and faulting
- Processes at plate boundaries, such as seafloor spreading
- Basic characteristics of various types of volcanoes
- Basic characteristics of earthquakes, including seismic waves and triangulation

E. Understands historical geology
- Principle of uniformitarianism
- Basic principles of relative age dating, including superposition, stratigraphic correlation, and fossil succession
- Absolute (radiometric) dating
- Geologic time scale (era and periods)
- Fossil record as evidence of the origin and development of life, including fossilization methods, mass extinctions, ice ages, and meteor impacts

Objective 2: Understands the hydrosphere and atmosphere, including water cycle, bodies of water, weather, and climate

The beginning Science teacher:

A. Understands the water cycle
- Evaporation and condensation
- Precipitation
- Runoff and infiltration
- Transpiration
- Properties of water that affect Earth systems such as density, changes on freezing, high heat capacity, and solvent properties

B. Understands the characteristics and processes of Earth's oceans and other bodies of water
- Distribution and location of Earth's water
- Seawater composition
- Coastline topography and topography of ocean floor
- Tides, waves, and currents
- Estuaries, barrier islands, islands, reefs, and atolls
- Polar ice, icebergs, and glaciers
- Lakes, ponds, and wetlands
- Streams, rivers, and river deltas
- Groundwater, water table, wells, aquifers, geysers, and springs

C. Understands the basic structure and composition of Earth's atmosphere
- Layers
- Composition of atmosphere
- Atmospheric pressure and temperature

D. Understands basic concepts of weather development
- Relative humidity
- Dew point
- Wind
- Cloud types and formation
- Types of precipitation
- Air masses, fronts, storms, and severe weather, such as hurricanes and tornadoes
- Development and movement of weather patterns

E. Understands the major factors that affect climate and seasons
- Effects of latitude, geographical location, and elevation
- Effects of atmospheric circulation, such as trade winds and jet streams
- Effects of ocean circulation
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- Greenhouse gases
- Ozone layer depletion
- Waste disposal and recycling
- Green chemistry
- Irrigation
- Reservoirs and levees
- Depletion of aquifers
- Loss of biodiversity

B. Understands major issues associated with energy production and the management of natural resources
- Renewable and nonrenewable energy resources
- Conservation, recycling, and sustainability
- Pros and cons of power generation based on various sources, such as fossil and nuclear fuel, hydropower, wind power, solar power, and geothermal power
- Issues associated with the use and extraction of Earth's resources (e.g., mining, land reclamation, and deforestation)

C. Understands applications of science and technology in daily life
- Chemical properties of household products
- Communication (e.g., wireless devices, GPS, satellites)
- Science principles applied in commonly used consumer products such as batteries, lasers, polarized sunglasses, and fiber optic cables
- Water purification
- Common agricultural practices, such as the use of insecticides, herbicides, and genetically modified crops
- DNA evidence in criminal investigations

D. Understands the impact of science on public health issues
- Nutrition, disease, and medicine
- Biotechnology, such as genetic engineering
- Medical technologies, such as medical imaging, X rays, and radiation therapy

- Folding and faulting
- Processes at plate boundaries, such as seafloor spreading
- Basic characteristics of various types of volcanoes
- Basic characteristics of earthquakes, including seismic waves and triangulation

E. Understands historical geology
- Principle of uniformitarianism
- Basic principles of relative age dating, including superposition, stratigraphic correlation, and fossil succession
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- Polar ice, icebergs, and glaciers
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- Streams, rivers, and river deltas
- Groundwater, water table, wells, aquifers, geysers, and springs

C. Understands the basic structure and composition of Earth's atmosphere
- Layers
- Composition of atmosphere
- Atmospheric pressure and temperature

D. Understands basic concepts of weather development
- Relative humidity
- Dew point
- Wind
- Cloud types and formation
- Types of precipitation
- Air masses, fronts, storms, and severe weather, such as hurricanes and tornadoes
- Development and movement of weather patterns

E. Understands the major factors that affect climate and seasons
- Effects of latitude, geographical location, and elevation
- Effects of atmospheric circulation, such as trade winds and jet streams
- Effects of ocean circulation
- Characteristics and locations of climate zones, such as the Tropics and the Arctic
- Effect of the tilt of Earth's axis on seasons
- Effects of natural phenomena, such as volcanic eruptions and solar radiation variations
- El Niño, La Niña, and monsoons

Objective 3: Understands astronomy, including solar system, stars, and other features of the universe

The beginning Science teacher:

A. Understands the major features of the solar system
- Structure of the solar system
- Effects of motion and gravity
- Characteristics of the Sun, Moon, and planets
- Characteristics of asteroids, meteoroids, comets, and dwarf/minor planets
- Theories of the origin of the solar system

B. Understands the interactions of the Earth-Moon-Sun system
- Effect on seasons
- Effect on tides
- Earth's rotation and orbital revolution around the Sun
- Phases of the Moon
- Solar and lunar eclipses
- Time zones
- Effect of solar wind on Earth

C. Understands major features of the universe
- Galaxies
- Characteristics of stars and their life cycles
- Dark matter
- Theories of the origin of the universe
- Technology and measurement techniques used to investigate the universe, such as telescopes, spectroscopes, and probes

Subarea II: Earth and Space Science

Objective 1: Understands geology, including Earth's structure, rocks, minerals, plate tectonics, and historical geology

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GACE

Objective 2: Understands the hydrosphere and atmosphere, including water cycle, bodies of water, weather, and climate

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What do pre-service teachers need to know to be successful teaching Earth science

I. The exam: GACE

GACE
Georgia Assessments for the Certification of Educators®

OFFICIAL EXAMINEE SCORE REPORT

Georgia Cert. ID: 1178495
Test Date: 12/18/2013
ETS ID No.: 10487475

Your Score

014 - Middle Grades Science

Assessment Passed at Induction Level

Your Scaled Score 246

100	Induction Passing Score 220	Professional Passing Score 250	300

About Your Score Report

Scores for other assessments taken on this date are in separate score reports.
Please see *Understanding Your GACE® Scores* and the Study Companion for this assessment for detailed information about this assessment and how to interpret and to most effectively use the information presented in this score report. Both are available as free downloads on the GACE website at www.gace.ets.org.

The GaPSC is in the process of raising the passing standard for educator content knowledge in Georgia. As a beginning step in this process, your score report shows information about passing scores at two levels: an induction passing score and a professional passing score. **At this time, examinees passing a GACE assessment at the induction level or the professional level have met the Georgia Special Requirement to pass the content knowledge assessment(s) appropriate to the field of certification.** See *Understanding Your GACE® Scores* for additional information.

Score information in this score report is reported to the Georgia Professional Standards Commission (GaPSC), the program provider that authorized you to take this assessment, and any other score recipients you indicated during registration.

This score report will be accessible to you for 50 years from the test date. Please save a copy of this PDF and print and retain a copy of it for your future reference.

Your Highest Score to Date*

Code - Test Name	Status	Test Date	Scaled Score Range	Induction Passing Score	Professional Passing Score	Your Scaled Score
014 - Middle Grades Science	Passed Induction	12/18/2013	(100-300)	220	250	246

GACE
Georgia Assessments for the Certification of Educators®

OFFICIAL EXAMINEE SCORE REPORT

Georgia Cert. ID: 1178495
Test Date: 12/18/2013
ETS ID No.: 10487475

014 - Middle Grades Science

Performance Analysis for Selected-Response (SR) Questions*

Number Correct of SRs: 38

Total SR Questions: 60

Detailed Performance Analysis for Selected-Response (SR) Questions*

Subareas and Objectives	Scored Questions	Number Correct
Subarea I. Scientific Inquiry, Processes, Technology, And Society	12	9
1. Understands the nature of scientific inquiry and processes, including the collection and analysis of data	6	5
2. Understands the relationship of science and technology to society and the environment	6	4
Subarea II. Physical Science	18	8
1. Understands the organization of matter, the atomic model, and relationships involving energy and matter	6	3
2. Understands chemistry, including periodic table, compounds, formulas, bonding, reactions, and solutions	6	4
3. Understands physics, including mechanics, electricity and magnetism, and wave properties	6	1
Subarea III. Life Science	18	10
1. Understand the structure of cells and cellular processes, basic genetics, and the mechanisms of evolution	8	4
2. Understands characteristics of organisms and principles of ecology	10	6
Subarea IV. Earth And Space Science	12	11
1. Understands geology, including Earth's structure, rocks, minerals, plate tectonics, and historical geology	6	6
2. Understands the hydrosphere and the atmosphere, and astronomy	6	5

*This does not include questions that were included for research purposes and are not scored.

GA Middle Grades Science Standards

Co-Requisite-Content

S6E1. Students will explore current scientific views of the universe and how those views evolved.

a. Relate the Nature of Science to the progression of basic historical scientific models (geocentric, heliocentric) as they describe our solar system, and the Big Bang as it describes the formation of the universe.

b. Describe the position of the solar system in the Milky Way galaxy and the universe.

c. Compare and contrast the planets in terms of Size relative to the earth Surface and atmospheric features Relative distance from the sun Ability to support life

d. Explain the motion of objects in the day/night sky in terms of relative position.

e. Explain that gravity is the force that governs the motion in the solar system.

f. Describe the characteristics of comets, asteroids, and meteors.

S6E2. Students will understand the effects of the relative positions of the earth, moon and sun.

a. Demonstrate the phases of the moon by showing the alignment of the earth, moon, and sun.

b. Explain the alignment of the earth, moon, and sun during solar and lunar eclipses.

c. Relate the tilt of the earth to the distribution of sunlight throughout the year and its effect on climate.

S6E3. Students will recognize the significant role of water in earth processes.

a. Explain that a large portion of the Earth's surface is water, consisting of oceans, rivers, lakes, underground water, and ice.

b. Relate various atmospheric conditions to stages of the water cycle.

c. Describe the composition, location, and subsurface topography of the world's oceans.

d. Explain the causes of waves, currents, and tides.

S6E4. Students will understand how the distribution of land and oceans affects climate and weather.

a. Demonstrate that land and water absorb and lose heat at different rates and explain the resulting effects on weather patterns.

b. Relate unequal heating of land and water surfaces to form large global wind systems and weather events such as tornados and thunderstorms.

c. Relate how moisture evaporating from the oceans affects the weather patterns and weather events such as hurricanes.

S6E5. Students will investigate the scientific view of how the earth's surface is formed.

a. Compare and contrast the Earth's crust, mantle, and core including temperature, density, and composition.

b. Investigate the contribution of minerals to rock composition.

c. Classify rocks by their process of formation.

d. Describe processes that change rocks and the surface of the earth.

e. Recognize that lithospheric plates constantly move and cause major geological events on the earth's surface.

f. Explain the effects of physical processes (plate tectonics, erosion, deposition, volcanic eruption, gravity) on geological features including oceans (composition, currents, and tides).

g. Describe how fossils show evidence of the changing surface and climate of the Earth.

h. Describe soil as consisting of weathered rocks and decomposed organic material.

i. Explain the effects of human activity on the erosion of the earth's surface.

j. Describe methods for conserving natural resources such as water, soil, and air.

S6E6. Students will describe various sources of energy and with their uses and conservation.

a. Explain the role of the sun as the major source of energy and its relationship to wind and water energy.

b. Identify renewable and nonrenewable resources.

AAAS Middle Grades Science Standards

Properties of Earth Materials

- Earth materials are solid rocks and soils, water, and the gases of the atmosphere. The varied materials have different physical and chemical properties, which make them useful in different ways, for example, as building materials, as sources of fuel, for growing the plants we use as food. Earth materials provide many of the resources that humans use.
- Soils have properties of color and texture, capacity to retain water, and ability to support the growth of many kinds of plants, including those in our food supply.
- Fossils provide evidence about the plants and animals that lived long ago and the nature of the environment at that time.

Objects in the Sky

- The Sun, Moon and Stars, clouds, birds, and airplanes all have properties, locations, and movements that can be observed and described.
- The Sun provides the light and heat necessary to maintain the temperatures of the Earth.

Changes in the Earth and Sky

- The surface of the Earth changes. Some changes are due to slow processes, such as erosion and weathering, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes.
- Weather changes from day to day and over the seasons. Weather can be described by measurable quantities, such as temperature, wind direction and speed, and precipitation.
- Objects in the sky have patterns of movement. The Sun, for example, appears to move across the sky in the same way everyday, but its path changes slowly over the seasons. The Moon moves across the sky on a daily basis much like the Sun. The observable shape of the Moon changes from day to day in a cycle that lasts about a month.

AAAS Middle Grades Science Standards

Structure of the Earth System

- The solid Earth is layered with a lithosphere; hot, convecting mantle: and dense, metallic core.
- Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate movements.
- Landforms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.
- Some changes in the solid earth can be described as the "rock cycle." Old rocks at the Earth's surface weather, forming sediments that are buried, then compacted, heated, and often re-crystallized into new rock. Eventually, those new rocks may be brought to the surface by the forces that drive plate motions, and the rock cycle continues.
- Soil consists of weathered rocks and decomposed organic material from dead plants, animals, and bacteria. Soils are often found in layers, with each having a different chemical composition and texture.
- Water, which covers the majority of the Earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the "water cycle." Water evaporates from the earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soil, and rocks underground.
- Water is a solvent. As it passes through the water cycle is dissolves minerals and gases and carries them to the oceans.
- The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor. The atmosphere has different properties at different elevations.
- Clouds, formed by the condensation of water vapor, affect weather and climate.
- Global patterns of atmospheric movement influence local weather, because water in the oceans holds a large amount of heat.
- Living organisms have played many roles in the Earth system, including affecting the composition of the atmosphere, producing some types of rocks, and contributing to the weathering of rocks.

AAAS Middle Grades Science Standards

Earth's History

- The Earth processes we see today, including erosion, movement of the lithospheric plates, and changes in atmospheric composition, are similar to those that occurred in the past. Earth history is also influenced by occasional catastrophes, such as the impact of an asteroid or comet.
- Fossils provide important evidence of how life and environmental conditions have changed.

Earth in the Solar System

- The Earth is the third planet from the Sun in a system that includes the Moon, the Sun, eight other planets and their moons, and smaller objects, such as asteroids and comets. The Sun, an average star, is the central and largest body in the Solar System.
- Most objects in the Solar System are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the moon, and eclipses.
- Gravity is the force that keeps planets in orbit around the Sun and governs the rest of the motion in the Solar System. Gravity alone holds us to the Earth's surface and explains the phenomena of the tides.
- The Sun is the major source of energy for phenomena on the Earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. Seasons result from variations in the amount of the Sun's energy hitting the surface, due to the tilt of the Earth's rotation on its axis and the length of the day.

AAAS Middle Grades Science Standards

Energy in the Earth System

- Earth systems have internal and external sources of energy, both of which create heat. The Sun is the major external source of energy. Two primary sources of internal energy are the decay of radioactive isotopes and the gravitational energy from the Earth's original formation.
- The outward transfer of Earth's internal heat drives convection circulation the mantle that propels the plates comprising the Earth's surface across the face of the globe.
- Heating of the Earth's surface and atmosphere by the Sun drives convection within the atmosphere and oceans, producing winds and ocean currents.
- Global climate is determined by energy transfer from the sun at and near the Earth's surface. This energy transfer is influenced by dynamic processes such as cloud such as cloud cover and the earth's rotation, and static conditions such as the position of the mountain ranges and oceans.

Geochemical Cycles

- The Earth is a system containing essentially a fixed amount of each stable chemical atom or element. Each element can exist in several different chemical reservoirs. Each element on Earth moves among reservoirs in the solid earth, oceans, atmosphere, and organisms as part of geochemical cycles.
- Movement of matter between reservoirs is driven by the Earth's internal and external sources of energy. These movements are often accompanied by a change in the physical and chemical properties of matter. Carbon, for example, occurs in carbonate rocks such as limestone, in the atmosphere as carbon dioxide gas, in water as dissolved carbon dioxide, and in all organisms as complex molecules that control the chemistry of life.

AAAS Middle Grades Science Standards

The Origin and Evolution of the Earth System

- The Sun, the Earth, and the rest of the Solar System formed from a nebular cloud of dust and gas 4.6 billion years ago. The early Earth was very different from the planet we live on today.
- Geologic time can be estimated by observing rock sequences and using fossils to correlate the sequences at various locations. Current methods include using the known decay rates of radioactive isotopes present in rocks to measure the time since the rock was formed.
- Interactions among the solid earth, the oceans, the atmosphere, and organisms have resulted in the ongoing evolution of the Earth system. We can observe some changes such as earthquakes and volcanic eruptions on a human time scale, but many processes, such as mountain building and plate movements take place over hundreds of millions of years.
- Evidence for one-celled forms of life—the bacteria—extends back more than 3.5 billion years. The evolution of life caused dramatic changes in the composition of the Earth's atmosphere, which did not originally contain oxygen.

The Origin and Evolution of the Universe

- The origin of the universe remains one of the greatest questions in science. The "big bang" theory places the origin between 10 and 20 billion years ago, when the universe began in a hot, dense state; according to this theory, the universe has been expanding ever since.
- Early in the history of the universe, matter, primarily the light atoms hydrogen and helium, clumped together by gravitational attraction to form countless trillions of stars. Billions of galaxies, each of which is a gravitationally bound cluster of billions of stars, now form most of the visible mass in the universe.
- Stars produce energy from nuclear reactions, primarily the fusion of hydrogen to form helium. These and other processes in stars have led to the formation of all the other elements.

FVSU College of Education Mission Statement

We are in the process of designing cutting-edge educator preparation programs that will meet and exceed the standards of our accrediting agencies. The College of Education is committed to the preparation of "proficient educators" who are competent in content, pedagogy, and technology, as well as educators who possess a caring disposition while understanding and appreciating diversity. This commitment is implemented through our partnerships with the College of Arts and Sciences and area public schools.

The following are the standards of a Proficient Educator, and the core of our teacher preparation program:
The Proficient Educator demonstrates competence in content knowledge;
The Proficient Educator uses effective pedagogical skills;
The Proficient Educator uses technology appropriately to enhance learning;
The Proficient Educator evidences a caring disposition; and
The Proficient Educator has an understanding of and

Language Arts Concentration: (9 hours)
ENGL 3343 Contemporary American Literature OR
ENGL 2153 The Grammar of Literary Criticism;
ENGL 3500 Grammar for Teachers and Writers; and
ENGL 4520 Literature for Middle Grades
Mathematics Concentration:
MATH 3400 Geometry for K-8 Teachers;
MATH 3510 Algebraic Concepts; and
MATH 4000 Calculus Concepts OR
MATH 3100 Discrete Math and Statistics
Reading Concentration:
READ 3623 Differentiated Instruction for Reading and Writing in the Middle Grades;
READ 3723 Classroom Literacy Assessment and Instruction; and
READ 3924 Teaching Reading to Culturally Diverse and Special Needs Students

Science Concentration:

SCIE 3103 Principles of Environmental Science
SCIE 3102 Principles of Physical Science; and
SCIE 3121 Principles of Geology

Social Sciences Concentration:
HIST 3309 Survey of West Africa OR
GEOG 4405 Geography of Africa
HIST 3311 Georgia in American History
GEOG 4407 Geography of Asia
Pedagogy for Professional Educators:
EDMG 3131 Nature and Curriculum Needs of the Middle Grades Learner (60 clock hours)
EDMG 3132 Classroom Management Strategies
EDMG 3332 Methods of Teaching Language Arts/Reading in the Middle Grades
EDMG 3432 Methods of Teaching Social Studies in the Middle Grades
EDMG 3731 Middle School Practicum I (160 clock hours)
EDMG 3232 Methods of Teaching Science
EDMG 3532 Methods of Teaching Math
EDMG 3732 Middle School Practicum II (160 clock hours)
EDMG 4895 Teaching/Seminar (Capstone clinical experience of 600 clock hours).

Revised Oct. 2013

The University of Georgia
Franklin College of Arts & Sciences/College of Education
BS Biology/BSED Science Education – Biology Emphasis

NAME ____

Graduation & Program Requirements

_____ U.S. & Georgia Constitution	_____ Pre-professional Exp (50 hours)	_____ *Literature
_____ U.S. & Georgia History	_____ GACE Basic Skills	_____ *Multicultural _____ (ENGL 1102M)
_____ Physical Education	_____ *Biological Science	_____ *2 Social Sci (not HIST) _____; _____
_____ Environmental Literacy	_____ *Physical Science	_____ *2 FA/PHIL/RELI _____; _____
_____ Cultural Diversity (EFND 2120)	_____ *History	_____ *Foreign Language through 3rd semester

_____ FYOS 1001 (All freshman must complete this course within the first year of enrollment at UGA)

*See Franklin College website for specific courses that satisfy these requirements:
www.franklin.uga.edu/students/college_degree_requirements.php

GENERAL EDUCATION CORE (60-63 HOURS)

I. Foundation Courses (9-10 hours)

_____ 3	ENGL 1101	English Composition I
_____ 3	ENGL 1102/1102M	English Composition II
_____ 3	**MATH 2250 preferred****	

II. Sciences (7-8 hours) 1 physical science and 1 life science

_____ 4	____________	Physical Science **CHEM 1211-1211L preferred****
_____ 4	____________	Life Science **BIOL 1107-1107L preferred****

III. Quantitative Reasoning (3-4 hours)

_____ 4	____________	**PHYS 1111-1111L or 1211-1211L preferred****

IV. World Languages and Culture, Humanities and the Arts (12 hours)
World Languages and Culture (9); Humanities & Arts (3)

_____ 3	____________	World Languages and Culture (Foreign Language recommended*)
_____ 3	____________	World Languages and Culture (Foreign Language recommended*)
_____ 3	____________	World Languages and Culture (ARHI, RELI recommended*)
_____ 3	____________	Humanities and the Arts (Literature course recommended*)

V. Social Sciences (9 hours)

_____ 3	____________	POLS 1101 satisfies U.S. & GA Constitution requirements.
_____ 3	____________	HIST 2111 or 2112 satisfies U.S. & GA History requirements.
_____ 3	____________	(Social Science other than History recommended*)

VI. Courses Related to Program of Study (20 hours)

_____ 4	CHEM 1212-1212L	Freshman Chemistry II
_____ 4	CHEM 2211-2211L	Modern Organic Chemistry I
_____ 3	EDUC(EFND) 2110	Investigating Critical and Contemporary Issues in Education
_____ 3	EDUC(EFND) 2120	Exploring Social-Cultural Perspectives on Diversity
_____ 3	EDUC(EPSY) 2130	Exploring Learning and Teaching
_____ 3	SPED 4030	Survey of Special Education

*Fulfills Franklin College of Arts and Sciences requirements www.franklin.uga.edu/students/college_degree_requirements.php
**Preferred courses are effectively required for this major as they satisfy prerequisites for upper-level courses.
NOTE: A grade of C or better is required in all science and professional education courses. The University policy states that a grade of C- will not satisfy this grade requirement.

IMPORTANT: Dual degree students are required to meet with advisors from both colleges every semester.

MAJOR REQUIREMENTS (72-75 Hours)

Content Specialization 45-48 hours

_____ 4	BIOL 1108-1108L	Principles of Biology II
_____ 4	PHYS 1112-1112L or PHYS 1212-1212L	
_____ 4	CHEM 2212-2212L, STAT 2000, or MATH 2260	
_____ 4	GENE(BIOL) 3000	Evolutionary Biology
_____ 4	BCMB(BIOL) 3100	Biochemistry & Molecular Biology or BCMB 4010
_____ 4	GENE(BIOL) 3200	Genetics
_____ 4	CBIO(BIOL) 3300	Developmental Biology or CBIO(BIOL) 3400 Cell Biology
_____ 4	ECOL(BIOL) 3500/L	Ecology
_____ 3-4	BIOL __________	Organismal Biology Course
_____ 4	______________	BIOL Laboratory Course
_____ 3-4	______________	BIOL Elective
_____ 3-4	______________	BIOL Elective

Science Education 27 hours

_____ 3	ESCI 3450	Practicum in Science Education
_____ 3	ESCI 4450	Science Curriculum and Learning
_____ 3	ESCI 4460	Methods of Science Teaching
_____ 3	ESCI 4480	Technological Capabilities for Science Teaching
_____12	ESCI 5460	Science Education School Based Internship
_____ 3	ESCI 5470	Reflection on Science Teaching

P.E. 1 hour
_____ 1 PEDB Physical Education

Minimum semester Hours: 132-138 (not including PE)

UNITED STATES DEPARTMENT OF LABOR | BUREAU OF LABOR STATISTICS

OCCUPATIONAL OUTLOOK HANDBOOK

Geoscientists

Summary

Quick Facts: Geoscientists	
2012 Median Pay	\$90,890 per year \$43.70 per hour
Entry-Level Education	Bachelor's degree
Work Experience in a Related Occupation	None
On-the-job Training	None
Number of Jobs, 2012	38,200
Job Outlook, 2012-22	16% (Faster than average)
Employment Change, 2012-22	6,000


Geoscientists often work outdoors, sometimes in remote areas and in both warm and cold climates.

What Geoscientists Do

Geoscientists study the physical aspects of the Earth, such as its composition, structure, and processes, to learn about its past, present, and future.

Work Environment

Most geoscientists split their time between working in offices and laboratories, and working outdoors. Doing research and investigations outdoors is commonly called fieldwork and can require extensive travel to remote locations and irregular working hours.

How to Become a Geoscientist

Most geoscientist jobs require at least a bachelor's degree. In several states, geoscientists may need a license to offer their services to the public.

Pay

The median annual wage for geoscientists was \$90,890 in May 2012.

Job Outlook

Employment of geoscientists is projected to grow 16 percent from 2012 to 2022, faster than the average for all occupations. The need for energy, environmental protection, and responsible land and resource management is projected to spur demand for geoscientists in the future.

How to Become a Geoscientist

Geoscientists typically need at least a bachelor's degree for most entry-level positions. In several states, geoscientists may need a license to offer their services to the public.

Laboratory experience is important for prospective geoscientists.

Education

Geoscientists need at least a bachelor's degree for most entry-level positions. However, some workers begin their careers as geoscientists with a master's degree. A Ph.D. is necessary for most basic research and college teaching positions.

A degree in geosciences is preferred by employers, although degrees in physics, chemistry, biology, mathematics, engineering, or computer science are usually accepted if they include coursework in geology.

Most geosciences programs include geology courses in mineralogy, petrology, and structural geology, which are important for all geoscientists. In addition to classes in geology, most programs require students to take courses in other physical sciences, mathematics, engineering, and computer science. Some programs include training on specific software packages that will be useful to those seeking a career as a geoscientist.

Computer knowledge is essential for geoscientists. Students who have experience with computer modeling, data analysis, and digital mapping will be the most prepared to enter the job market.

Many employers seek applicants who have gained field and laboratory experience while pursuing a degree. Summer field camp programs offer students the opportunity to work closely with professors and apply their classroom knowledge in the field. Students can gain valuable experience in data collection and geologic mapping.

Important Qualities

Communication skills. Geoscientists write reports and research papers. They must be able to present their findings clearly to clients or professionals who do not have a background in geosciences.

Critical-thinking skills. Geoscientists base their findings on sound observation and careful evaluation of data.

Interpersonal skills. Most geoscientists work as part of a team with engineers, technicians, and other scientists.

Outdoor skills. Geoscientists may spend significant amounts of time outdoors. Familiarity with camping skills, general comfort being outside for long periods of time, and specific skills such as boat handling or even being able to pilot an aircraft could prove useful for geoscientists.

Physical stamina. Geoscientists may need to hike to remote locations while carrying testing and sampling equipment when they conduct fieldwork.

Problem-solving skills. Geoscientists work on complex projects filled with challenges. Geoscientists need to use and analyze complex sources of data. Evaluating statistical data and other forms of information to make judgments and inform the actions of other workers requires a special ability to perceive and address problems.

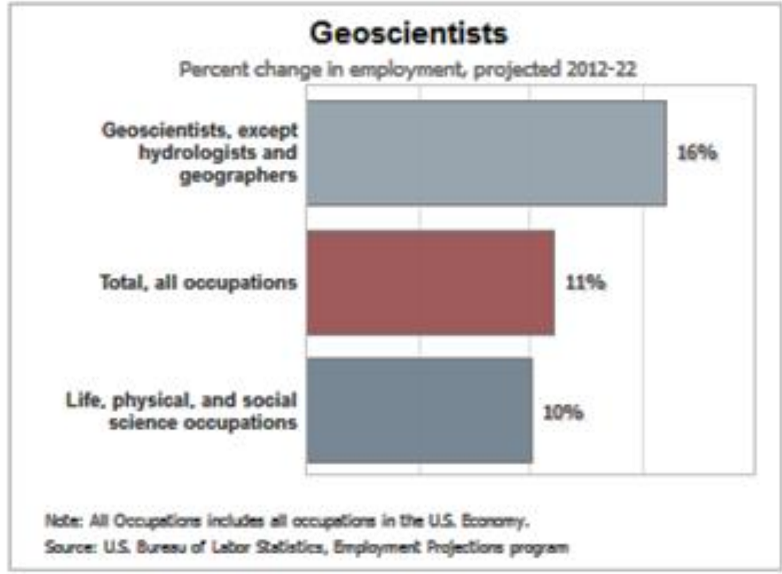
Licenses, Certifications, and Registrations

Geoscientists need a license to practice in some states. Requirements vary by state but typically include minimum education and experience requirements and a passing score on an exam.

OCCUPATIONAL OUTLOOK HANDBOOK

Geoscientists Job Outlook

Employment of geoscientists is projected to grow 16 percent from 2012 to 2022, faster than the average for all occupations. The need for energy, environmental protection, and responsible land and resource management is projected to spur demand for geoscientists in the future.



Horizontal drilling and hydraulic fracturing are examples of new technologies that are expected to increase demand for geoscientists. These technologies allow for the extraction of previously inaccessible oil and gas resources, and geoscientists will be needed to study effects they have on the surrounding areas. As oil prices remain high or increase into the future, even more technologies will likely be introduced that expand the ability to reach untapped oil reserves or introduce alternative ways to provide energy for the expanding population.

Geoscientists will be needed in planning for the construction of wind farms, geothermal power plants, and solar power plants. Alternative energies such as wind energy, geothermal energy, and solar power can use large areas of land and impact wildlife and other natural processes. In addition, only certain areas are suitable for harvesting these energies. For example, geothermal energy plants must be located near sufficient hot groundwater, and one task for geoscientists would be studying maps and charts to decide if the site is suitable.

An expanding population and the corresponding increased use of space and resources may create a continued need for geoscientists.

Job Prospects

Job opportunities should be excellent for geoscientists, but particularly those who earn a master's degree. In addition to job growth, a number of job openings are expected as geoscientists leave the workforce due to retirement and other reasons.

Geoscientists with a doctoral degree will likely face competition for positions in academia and research.

Fewer opportunities are expected in state and federal governments than in the past. Budget constraints are likely to limit hiring by state governments and federal agencies such as the U.S. Geological Survey. In addition, more of the work traditionally done by government agencies is expected to be contracted out to consulting firms in the future. Most opportunities for geoscientists are expected to be related to resource extraction; in particular, gas and oil exploration and extraction operations.

Employment projections data for geoscientists, 2012-22

Occupational Title	SOC Code	Employment, 2012	Projected Employment, 2022	Change, 2012-22		Employment by Industry
				Percent	Numeric	
Geoscientists, except hydrologists and geographers	19-2042	38,200	44,200	16	6,000	[XLS]

SOURCE: U.S. Bureau of Labor Statistics, Employment Projections program

UNITED STATES DEPARTMENT OF LABOR

BUREAU OF LABOR STATISTICS

OCCUPATIONAL OUTLOOK HANDBOOK

What Geoscientists Do

Geoscientists study the physical aspects of the Earth, such as its composition, structure, and processes, to learn about its past, present, and future.

Petroleum geologists (a type of geoscientist) search for oil and gas deposits that are suitable for commercial extraction.

Duties

Geoscientists typically do the following:

- Plan and conduct field studies, in which they visit locations to collect samples and conduct surveys
- Analyze aerial photographs, well logs (detailed records of geologic formations found during drilling), rock samples, and other data sources to locate natural resource deposits and estimate their size
- Conduct laboratory tests on samples collected in the field
- Make geologic maps and charts
- Prepare written scientific reports
- Present their findings to clients, colleagues, and other interested parties
- Review reports and research done by other scientists

Geoscientists use a wide variety of tools, both simple and complex. During a typical day in the field, they may use a hammer and chisel to collect rock samples and then use sophisticated ground-penetrating radar equipment to search for oil or minerals. In laboratories, they may use x-ray and electron microscopes to determine the chemical and physical composition of rock samples. They may also use remote sensing equipment to collect data and advanced geographic information systems (GIS) and modeling software to analyze data.

Geoscientists often supervise the work of technicians and coordinate work with other scientists, both in the field and in the lab.

Many geoscientists are involved in the search for and development of natural resources, such as petroleum. Others work in environmental protection and preservation, and are involved in projects to clean up and reclaim land. Some specialize in a particular aspect of the Earth, such as its oceans.

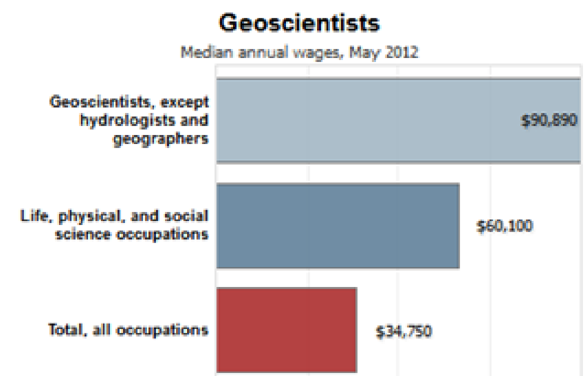
Geoscientists

Pay

The median annual wage for geoscientists was $90,890 in May 2012. The median wage is the wage at which half the workers in an occupation earned more than that amount and half earned less. The lowest 10 percent earned less than $48,270, and the top 10 percent more than $187,200.

In May 2012, the median annual wages for geoscientists in the top five industries employing these scientists were as follows:

Oil and gas extraction	$137,750
Federal government, excluding postal service	94,830
Engineering services	74,360
Management, scientific, and technical consulting services	74,020
State government, excluding education and hospitals	62,030



Note: All Occupations includes all occupations in the U.S. Economy.
Source: U.S. Bureau of Labor Statistics, Occupational Employment Statistics

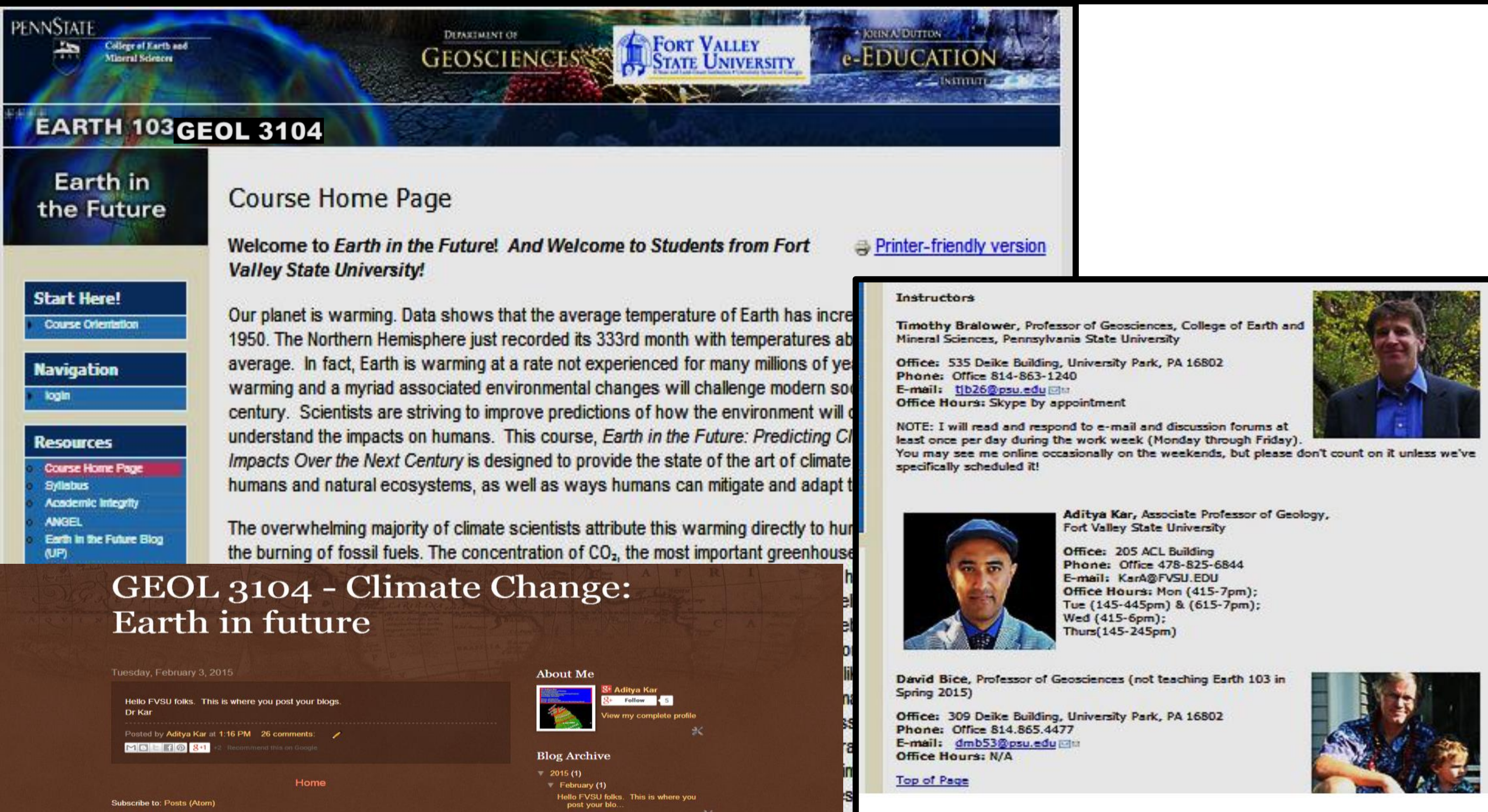
Most geoscientists work full time and may work long or irregular hours when doing fieldwork. Geoscientists travel frequently to meet with clients and to conduct fieldwork.

New InitiativeS to more Geo more relevant to URMs

Collegiate level – introduction of e-Course on Climate Change

Earth 103 at Penn State-
Earth in the future

GEOL 3104 at Fort Valley State University-
Climate Change: Earth in the future



INTEGRATE 2007 Teacher Education Workshop Outcome

As the focus on developing our nation's scientific workforce intensifies [National Academy of Sciences, 2007], more geoscience departments are recognizing teacher preparation as an integral part of their work. Skilled geoscience teachers can excite and engage K-12 students in the geosciences, present geoscience as a rewarding career path, and ultimately contribute to a better understanding of key geoscience problems among the public. Our ability to achieve these goals starts with the quality of our teacher education programs.

To address the growing demand for better prepared Earth science teachers in the nation's middle and high schools, 23 geoscience faculty met at Carleton College to compare geoscience courses designed for undergraduate students seeking to obtain certification as elementary, middle, and high school teachers.

The workshop had three main goals:

(1) build a community of educators involved in K-12 geoscience teacher preparation,

(2) examine the spectrum of ways in which geoscience teacher preparation courses are designed, and

(3) compile and publish course descriptions and peer reviewed course activities in a format accessible to other educators.

Several common themes emerged that participants identified as particularly important in preparing future teachers:

- A central focus on understanding what science is and how it is done, through either course activities or authentic investigations.
- An emphasis on the relevance of geoscience learning. The importance of relevance as a motivator for learning is widely recognized [National Research Council, 2000]. Teachers in particular need a deep understanding of relevance to motivate their own students.
- Focused course content that is purposefully chosen to align with state and/or national science standards so that future teachers become aware of what they are expected to teach.
- Opportunities for students to reflect upon the process of their own learning (metacognition). Developing metacognition is a critical step in enabling independent learning [National Research Council, 2000], a fundamental skill for teachers who need to stay current in both science and pedagogy.
- A learning environment that increases students' confidence in their abilities to both learn and teach science. A lack of confidence is known to hinder science teaching particularly at the elementary level [Tilgner, 1990].
- Instruction that allows students to make a connection between the content they are learning and the ways in which they will teach it in the future.

Participants took steps to continue building a community of K-12 geoscience teacher educators. Priorities established by participants included

- updating and maintaining the Teacher Preparation Web site and listserv,
- authoring a white paper and report on the importance of preparing future geoscience teachers,
- proposing a special issue of the Journal of Geoscience Education related to teacher preparation, and
- pooling resources to clearly ascertain best practices in geoscience teacher preparation

Like science, geoscience education is a community endeavor. We can be most effective if we share our insights and successes, build on our collective experiences, and work together to find the most important, durable ideas. Just as every mountain belt has a unique history, each academic department is unique—but geoscientists long ago discovered the power and fun of working together to understand them.

Volume 21 Issue 9 (September 2011); GSA TODAY; pp. 12-14
Improving undergraduate geoscience education—A community endeavor

That's ALL Folks!

ANY COMMENTS?
Direct it towards me

ANY QUESTIONS?
Ask Cheryl

FORT VALLEY STATE UNIVERSITY

A Presentation Prepared by:

Dr. Aditya Kar

Associate Professor of Geology

Dept. of Chemistry/Geology

Fort Valley State University

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