



Studying Geophysics in India

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Geophysics is an applied science that uses principles of physics to solve the problems related to the Earth and Planetary sciences such as earthquakes, volcanoes and exploration of mineral resources. It can be broadly divided into two branches: 1) solid earth geophysics, and 2) exploration geophysics. Solid earth geophysics is the study of the origin and interior structure of the planet earth and various processes that are changing the shapes of the earth; the scope of this branch is vast as it includes study of shallow to deep earth, earthquakes to moonquakes and also extends to the ocean and climate systems. Exploration geophysics focuses on applying geophysical methods to explore for (find and map) energy resources such as oil, coal, and uranium, and other mineral resources such as iron ore, gold, diamond, etc inside the earth. Exploration geophysicist studies the physical property of shallow subsurface up to few kilometers below the surface in search of mineral resources. Geophysical exploration methods remotely image the subsurface in terms of their physical properties (elastic moduli, density, electric and magnetic properties) and look for anomalies in the search of energy and mineral resources. Commonly used geophysical methods are: seismic, gravity, electrical, magnetic and electromagnetic. Each of the method has its own advantages in terms of minerals to be explored, required resolution and depth of penetration. For example, seismic method has become popular for oil exploration as it provides high resolution images of subsurface and helps in locating petroleum reservoirs. Similarly, gravity and magnetic methods are used for searching mineral resources while electrical and electromagnetic methods are commonly deployed for mapping water resources. As the easy exploration targets are exploited, there is a push to use various methods together in integrated analysis in exploration for difficult anomalies. These geophysical methods are also used for studying the structure of the earth. For example, the information about the earth's deep interior is derived from the seismic signal produced during an earthquake. Magnetic and gravity methods help in understanding the crustal structures and movement of continental and oceanic masses, formation of mountains and deep trenches. It is evident that geophysics is a very important and diverse subject, and it has a significant role to play in the two most important issues in future: energy and global environment.

Historically, geophysics has been taught in postgraduate level (Master/PhD) courses in India and abroad. One can obtain an undergraduate degree in basic sciences like geology, physics and/or math, and postgraduate degree in geophysics. In India, postgraduate courses in geophysics were started at Andhra University and Banaras Hindu Universities in 1949¹. Even now, most of the geophysics courses in India are postgraduate level but few universities have started integrated course in geophysics for students after intermediate (10+2 level) education. Most of the geophysics courses in India are focused on the exploration geophysics. As it can be seen in the list below the majority of the geophysics programs in India are called either exploration geophysics or applied geophysics, because of the better job opportunities they offer in petroleum industries, mining industries, and ground water related industries.

Indian Universities and their Geophysics Programs

- i. Indian Institute of Technology, Kharagpur (5-years Integrated M.Sc. in Exploration Geophysics, 2 years M.Sc. in Geophysics, and 2-years M.Tech. in Computational Seismology).
Web:
<http://www.iitkgp.ac.in/departments/home.php?deptcode=MG>
- ii. Indian Institute of Technology, Roorkee (5-years Integrated M.Tech. in Geophysical Technology, and 3-years M.Tech. in Applied Geophysics).
Web:
<http://www.iitr.ac.in/departments/ES/pages/index.html>
- iii. Indian Institute of Technology, Bombay (2-years M.Sc. in Applied Geophysics, 2-years M.Tech. in Geoexploration, and 2-years M.Tech. in Petroleum Geoscience).
Web:
<http://www.geos.iitb.ac.in>
- iv. Indian School of Mines University, Dhanbad (5-years Integrated M.Sc. Tech. in Applied Geophysics, and 3-years M.Sc. Tech in Applied Geophysics).
Web:
<http://www.ismdhanbad.ac.in/depart/geophysics/index.htm>



- v. Banaras Hindu University, Varanasi (3-years M.Sc. Tech in Exploration Geophysics or Meteorology). Web: <http://www.bhu.ac.in/geophysics/home.html>
- vi. Andhra University, Visakhapatnam (3-years M.Sc. Tech in Geophysics, 2-years M.Sc. in Hydrology, and 2-years M.Sc. in Marine Geophysics). Web: <http://www.andhrauniversity.info/science/geophysics/index.html>
- vii. Osmania University, Hyderabad (2-years M.Sc. in Geophysics). Web: <http://www.osmania.ac.in/Science%20College/1ndexpagel.htm>
- viii. Kurukshetra University, Kurukshetra (3-years M.Tech. in Applied Geophysics). Web: <http://kukinfo.com/dept/science/geop/geop.pdf>
- ix. Cochin University of Science and Technology (2-years M.Sc. in Marine Geophysics). Web: http://dept.cusat.ac.in/w_aboutdept.php?deptcode=marinegeo

Job opportunity

Geophysicists are in great demand both in industry and academia. There are various research opportunities in geophysics in both India and abroad. After obtaining a postgraduate degree in geophysics (or in a related science or engineering subjects) one can pursue further research towards PhD and Post-doctoral positions in India and abroad. Most of the Indian universities listed above as well as Indian research centers offer PhD research opportunities in geophysics. Some of the national laboratory actively involved in the development of earth sciences in India are National Geophysical Research Institute (NGRI) at Hyderabad (<http://www.ngri.org.in>), National Institute of Oceanography (NIO) at Goa (<http://www.nio.org>), Centre for Mathematical Modeling and Computer Simulation (C-MMACS) at Bangalore (www.cmmacs.ernet.in), National Environment Engineering Research Institute (NEERI) at Nagpur (www.neeri.res.in), Indian Institute of Geomagnetism (IIGM) at Mumbai (www.iigm.res.in), Indian Institute of Remote Sensing (IIRS) at Dehradun (www.iirs-nrsa.gov.in), National Institute of Ocean Technology (NIOT) at Chennai (<http://www.niot.res.in>), National Centre for Antarctic and Ocean Research (NCAOR) at Goa (www.ncaor.nic.in), Center for Earth Science Studies (CESS) at Thiruvananthapuram (<http://www.cessind.org>), Center for Development of Advanced Computing (CDAC) at Pune (<http://www.cdac.in>), Geological Survey of India (GSI) based in Kolkata (<http://www.gsi.gov.in>), Indian Institute of Science (IISC) at Bangalore (<http://ceas.iisc.ernet.in>), Physical Research

Laboratory (PRL) at Ahmedabad (<http://www.prl.res.in>), Wadia Institute of Himalayan Geology (WIHG) at Dehradun (www.wihg.res.in), Naval Physical Oceanographic Laboratory (NPOL) at Kochi (www.drdo.com/labs/npol/historical_background.html), and Bhabha Atomic Research Centre (BARC) at Mumbai (www.barc.ernet.in). Govt. of India provides research assistantships for PhD research. There are opportunities to get permanent scientist position in those research centers and faculty position in universities. There are also many universities and research centers around the world who always look for intelligent and motivated students/scholars.

Some of the industries that are keen in employing geophysics students include: petroleum industries, various mining industries, ground-water based industries, and cement industries. The job types can vary from field based to an office location working mostly with computers to analyze data. Recently there has been a great demand for geophysics students in petroleum industries and the opportunities are very lucrative. In India there are both government (public sector units) and private petroleum companies. Government petroleum companies are: Oil and Natural Gas Corporation Limited (ONGC) based in Dehradun (<http://www ONGCIndia.com>), Oil India Limited (OIL) based in Duliajan (<http://www.oil-india.com>), and Gujarat State Petroleum Corporation Limited (GSPC) (<http://www.gujaratpetro.com>). There are many domestic and international private petroleum companies currently operating in India such as Reliance Industries Limited (RIL) based in Mumbai (<http://www.ril.com>), Shell India Limited based in Bangalore (<http://www.shell.com>), Essar based in Mumbai (<http://www.essar.com/oil&gas.htm>), Cairn India based in Gurgaon (<http://www.cairnindia.com>), Hardy Exploration and Production (India) Inc based in Chennai (<http://www.hardyoil.com/assets.htm>), Selan Exploration Technology Limited based in Gurgaon (<http://www.selanexploration.com>), and Jubilant Enpro Limited based in Noida (<http://www.jubilantenpro.com>). Petroleum based domestic and international service companies in India are also interested in geophysics students, some of these companies are: Schlumberger (<http://www.slb.com>), WesternGeco (<http://www.westerngeco.com>), Halliburton (<http://www.halliburton.com>), Fugro (<http://www.fugro.in>), Fugro-Jason (<http://www.fugro-jason.com>), CGGVeritas (<http://www.cggveritas.com>), and Petroleum Geoservices (PGS) (<http://www.pgs.com>).

Geophysical society

Professional societies provide a platform to share, interact and discuss technology and challenges. Three geophysical societies in India are: Society of Petroleum Geophysicist (SPG) based in Dehradun



(www.spgindia.org), Association of Exploration Geophysicists (AEG) based in Hyderabad (<http://www.aegindia.org>), and Indian Geophysical Union based in Hyderabad (<http://www.igu.in>). These societies are always interested in helping students in education, research collaboration, providing resources (data, books and software), financial support (scholarships and travel grants to attend conferences) and even job opportunities. SPG has local chapters in various cities and universities in India for better and frequent interactions. SPG has also an international chapter operating from USA, which is called the North American Chapter (<http://www.spgnorthamerica.org>). It includes Indian origin geophysicists from North America (USA and Canada) as well as Indian geophysicists based in other foreign countries. There are many international geophysical societies that provide a global platform, and they promote geophysics education/research and help geophysics students from worldwide universities. Some of these international societies are: Society of Exploration Geophysicists (SEG) based in Tulsa, USA (<http://www.seg.org>), European Association of Geoscientists and Engineers (EAGE) based in the Netherlands (<http://www.eage.org>), and American Geophysical Union (AGU) based in Washington DC, USA (<http://www.agu.org>). Every geophysical society conducts annual or biannual conferences and many other workshops and symposiums. For example, SEG, EAGE, and AGU conduct annual conference; SPG and Petrotech (<http://www.petrotechsociety.org>) organize conferences in alternate years (complimentary to each other) in the month of January. Petrotech organized its 8th conference in New Delhi in January 2009 and SPG plans to have their 8th biannual conference in Hyderabad during 18-20 January 2010. Students are very welcome to these society meetings; there are several programmes organized especially for students. So, keep an eye on these meetings and plan/apply in advance to attend these conferences as you might receive various advantages over others including financial support. Students can also submit abstract based on present research to present during the conference and that will help them get recognized by professional geophysicists, find a job, and get research assistantships for further research.

Summary

Geophysics is an applied science that uses many science and engineering subjects to study earth related problems. There are nine universities in India providing postgraduate education in geophysics. Most are focused on exploration geophysics that prepares students for job opportunities in petroleum, ground water, cement, and mining industries. Exploration geophysics is an integrated science that is very interesting and provides great job opportunities. However, solid earth geophysics is

also very important as it studies global earth system and there is a need to emphasize this in Indian education and research. Professional societies in India and abroad are great resources for students to network, learn from experienced geophysicists, collaborate on research projects and are even useful to find jobs. I personally recommend high school, intermediate school, and undergraduate students to consider geophysics as a subject in future studies. Also, I strongly recommend present geophysics students and professional geophysicists to consider getting associated with geophysical societies in India and abroad.

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Reference

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