Ankan Basu, CPG. P.G.

Hydrogeologist / Geochemist

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Objective

Mr. Basu is a Certified Professional Geologist (CPG) with over 10 years of professional experience in hydrogeology, geochemistry, environmental issues, engineering and mining. In addition to geology skills, Mr. Basu is an accomplished programmer and data analyst with a special interest in geological, geochemical and hydrogeologic data visualization. Mr. Basu is currently pursuing a degree in computer science. He is also an experienced ArcGIS user and completed developing several GIS based map applications.

A major part of his work has involved geological, geochemical and groundwater investigations including assessment of probable hydrologic consequences (PHC), investigations of water quality and/or quantity impacts, analytical and numerical groundwater modeling, inflow prediction to tunnels, slope, shaft etc. He has helped clients with designing, planning, and overseeing site investigations, contamination assessments, and hydrogeologic investigations, including aquifer testing. He is highly experienced in monitoring well installation, pump tests, water balance studies, preparation of analytical and numerical groundwater models in ANAQSIM and MODFLOW.

He has also helped several mining companies to remediate acid-mine drainages, and other toxic metals such as lead, selenium and mercury. Mr. Basu has prepared several geochemical models using PHREEQC and Geochemist's Workbench to produce solubility diagram and to predict post mining geochemical conditions. He has completed several investigation and remediation of soil and groundwater contaminated sites. In addition to several complex spreadsheet analyses, he has coded several scripts to automate geochemical data analysis and graph generation such as scatter plots, regression analyses, time series evaluation etc.

Additionally, he has also conducted numerous mineral resource and as a competent person. He has supervised and managed several projects involving exploration, geotechnical studies, and preparation of 3D geologic model using various tools such as CARLSON and SURFER.

Mr. Basu is a strong supporter of open source development and many of his own software codes are available at the Git repository: https://github.com/hydrogeologist, which reflects the complexity of programs developed by Mr. Basu, as well as usefulness of them for various geological, geochemical and hydrogeologic applications.

Application Softwares

- 3D Modeling: Carlson SurvCADD; SURFER, AutoCAD, ArcGIS, QGIS
- Geochemical Modeling: Geochemist's Workbench, PHREEQC – Geochemical Modeling
- Hydro: AQTESOLV, MODFLOW, AnAqSIM
- Programming languages: R, Python, C, C++, JAVA, PHP, FORTRAN
- Database management: MySQL, Access.

(Note: all computer codes developed during various school projects are also available at the Git repository; for example all project codes for JAVA programming can be cloned from https://github.com/hydrogeologist/JAVA_Introduction_To_Computing.git)

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Education and Credentials

- **Associate in Computer Science – currently enrolled (2015)**
  New River Community College, Christiansburg, VA.
- **Masters of Science – Geology (concentration Hydro-geochemistry)**
  Virginia Polytechnic Institute and State University, Blacksburg, VA, 2006
- **Masters of Science – Geology (concentration Geochemistry)**
  Georgia State University, Atlanta, GA, USA, 2004
- **Masters of Science – Applied Geology (concentration Metamorphic petrology)**
  Indian Institute of Technology, Kharagpur, India, 2002
- **Bachelor of Science, Earth sciences**; Minor: Chemistry, Mathematics
  Jadavpur University, West Bengal, India, 2000

Professional Certifications:

- Certified Professional Geologist (CPG), Certificate No# 2801001899, State of Virginia
- Registered Professional Geologist (RPG), Certificate No# 5745, State of Tennessee
- Licensed Professional Geologist (LPG), Certificate No# KY-2567, State of Kentucky
- Certified Professional Geologist (CPG); Certificate No# 2013012068, State of Missouri
- Certified Professional Geologist (CPG); Certificate No# PG002116, Georgia
- Certified Professional Geologist (CPG, AIPG); Certificate No# CPG-11576
- SME Registered Member # 4187929RM

Awards:

- University Gold Medal in Bachelor's of Science (2000) from Jadavpur University, India.
- National Scholarship (1997) from Govt. of West Bengal, India.

Publications on Geochemistry issues:

- **Basu, Ankan & Schreiber, M (2012):** Arsenic release from arsenopyrite weathering: Insights from sequential extraction and microscopic studies; Journal of Hazardous Materials; http://dx.doi.org/10.1016/j.jhazmat.2012.12.027
- **Basu, Ankan (2006):** Assessment of Arsenic Mobility using Sequential Extraction and Microscopic Methods; Thesis *submitted to Virginia Tech for Master of Science*
- **W. Crawford Elliott, Ankan Basu , J. Marion Wampler , R. Douglas Elmore and Georg H. Grathoff (2006);** Comparison of K-Ar ages of diagenetic illite-smectite to the age of a

chemical remanant magnetization (CRM): An example from the isle of Skye, Scotland, *Clays and Clay Minerals*; June 2006; v. 54; no. 3; p. 314-323; DOI: 10.1346/CCMN.2006.0540303.

- **Blumstein, A. M., R. D. Elmore; M. H. Engel; C. Elliot; and A. Basu (2004);** Paleomagnetic dating of burial diagenesis in Mississippian carbonates, Utah, J. Geophys. Res., 109, B04101, doi: 10.1029/2003JB002698.
- **Basu, Ankan (2004):** A Comparison of K-Ar Ages of Illite to the Age of Chemical Ramnant Magnetization; *Thesis submitted to Georgia State University for Master of Science; 107p*.
- **Basu, Ankan (2002):** Metamorphic History of Sausar Belt, India; Thesis *submitted to Indian Institute of Technology for Master of Science*.

Abstracts presented on geochemistry issues:

- **Basu A and Schreiber M; 2005**. Geochemistry of arsenic in mine tailing deposits. Graduate Student Research Symposium.
- **Basu A and Schreiber M**; **2004.** Spectroscopic and Microscopic analysis of arsenic contaminated sediments. Graduate Student Research Symposium.
- **Basu A and Elliott C; 2003.** Remagnetization and Clay diagenesis in Jurassic Sediments of Skye, Scotland, American Geological Union Fall Meeting CA.

Certificates:

- 40 Hr. OSHA HAZWOPER
- Alpha Spectrometry Training Certificate.
- Mine Safety and Health Administration (MSHA) Training.
- First Responder HAZ MAT Awareness Training.

Professional Affiliation

- The Geological Society of America (GSA)
- Sigma Gamma Epsilon (SGE)
- American Institute of Professional Geologists (AIPG)
- American Association of Petroleum Geologists (AAPG)
- Society for Mining, Metallurgy and Exploration (SME)

Professional Experience:

Hydrogeologist / Geochemist, 2006-Present
CARDNO (previously: Marshall Miller & Associates), Bluefield, Virginia.
As a hydrogeologist/Geochemist Mr. Basu has completed a wide variety of projects starting from drilling and exploration to complicated statistical regression analysis. The core geology work at CARDNO typically revolves around coal exploration, reserve delineation, structural mapping of folds and faults, 3D modeling of resource area, and performing volumetric calculations. Geologic, geotechnical logging, sampling and geophysical interpretation usually accompany every exploration projects.

As a geochemist, duties include analysis of complex geochemical data from various experimental studies such as Acid Base Accounting (ABA), column leach tests etc. Often time, drilling and sampling for geochemical tests. Over the years, Mr. Basu has developed various computer codes to visualize geochemical data, and to perform in-depth regression analysis using statistical programming language R (similar to Matlab). He has also helped a regulatory agency to delineate an ABA sampling plan. He has also used both "Geochemist Workbech" and "PHREEQC" to perform geochemical analyses. He also works closely with fellow engineers and specializes in bioreactor design especially for selenium treatment.

As a hydrogeologist Mr. Basu routinely performs monitoring well installations, pump tests, packer tests, prepare potentiometric maps, calculate and predict seepage and inflow, prepare flownets. He has also developed several numerical models in MODFLOW to predict flow in unground mines. Apart from MODFLOW, he also uses analytical models such as AnAqSIM for groundwater flow modeling.

Mr. Basu uses various software and programming languages to automate data evaluation and statistical analysis. He is also an accomplished programmer and has in depth knowledge in many programming languages including JAVA, Python, R, PHP, C++ and FORTRAN.
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A list of selected projects with brief description is attached at the end of this resume.

Research / Teaching Assistant, Virginia Tech, USA 2004-2006
As a research fellow at Virginia Tech, Atlanta, Mr. Basu performed experiments to understand release mechanism of arsenic in groundwater. He used sequential extraction method to understand the ease of arsenic release under various geochemical conditions. He has also used scanning electron microscope (SEM) to determine mineralogy of the soil and rock samples. He has also installed several monitoring wells and taught graduate level ground water laboratory class in Virginia tech.

Research / Teaching Assistant, Georgia State University, USA 2002-2004

As a research fellow at Georgia State University, Atlanta, Mr. Basu completed experiments to determine mineralogy of clay-samples using X-ray diffraction technology and estimated age of soil samples based on K-Ar dating technique. He has also taught several introductory geology labs in the university.

Research Assistant, Indian Institute of Technology, India, 2000-2002

As a research fellow at Indian Institute of Technology, Mr. Basu performed examination of mineralogy of metamorphic rocks to understand the history of metamorphic evolution. He has also used Alpha Spectrometer to investigate the aerosol load in one of the most populist cities in India – Ahmedabad.

Continued Education:

A list of selected courses completed in last 3 years is presented below. A complete list of certificates and courses completed is available at https://www.linkedin.com/in/ankanbasu

- Introduction to Programming in JAVA
- Introduction to Engineering
- An Introduction to Interactive Programming in Python
- Programming for Everybody (Python)
- Learn to Program: The Fundamentals
- Advanced Chemistry
- Computing for Data Analysis
- Statistical Reasoning for Public Health 1: Estimation, Inference, & Interpretation
- The Data Scientist's Toolbox
- Preparing for the AP* Statistics Exam
- New Models of Business in Society
- From GPS and Google Maps to Spatial Computing
- Getting started with GIS
- Introduction to programming –data structure with JAVA
- Visual C++ programming for game development

Key skills and consulting services

Hydrogeologic
- Preparation of analytical and numerical modes using Anaqsim, MODFLOW.
- Aquifer testing (Packer test, Pump test, Slug test); interpretation of field data; derivation hydrologic parameters (AQTESOLV)
- Monitoring well installation, sampling, water user inventory
- Interpretation of wire-line geophysical logs for aquifer identification; water level and rock type determination.
- Mine inflow prediction, inflow to slope and shaft determination, seepage through barrier estimation;
- Stream-flow measurement and evaluation of data.
- Hydrologic balance assessment associated with mining activities.
- Underground Injection Control (UIC) permits preparation.

Geophysical
- Interpretation of data from wire-line geophysical tools such as gamma log, density logs, sonic logs, caliper logs and acoustic televiewer (ATV) logs; interpret geology and define major aquifers.

Geochemical
- Preparation of geochemical models using PHREEQC and Geochemist's Workbench
- Evaluation of water quality data; QA/QC; Stiff and Piper diagrams;
- Acid Base Account (ABA) and Se sampling and data analysis for all coal related projects.
- Soil sampling and strength tests especially for slope and shaft development projects.
- RCRA metal remediation; bioremediation, Acid Mine Drainage analysis.

Mineral explorations
- Qualified Person for JORC / CIM or US SEC reserve/resource studies.
- Preparation of 3D-Geological model of mineral resources (Software: CARLSON or SurvCADD);
- Exploration and economic assessment of natural mineral deposits, field supervision of drilling; field mapping, geologic /geotechnical and fracture (RQD) logging of core.
- Isopach mapping; fault and lineaments delineation; preparation of geologic reports
- Mine hazard evaluation; roof and floor mapping.
- Sampling and analysis of Coal Bed Methane (CBM).
- Geotechnical investigation; strength testing; Rock Mass Rating (RMR) evaluation.

Soil:
- Geo-probe sampling, supervision of boring
- Evaluation of geochemistry of soil from storm water basins.

List of Selected Projects / activities at Cardno MM&A (2006 to Present)

Hydrologic Investigations:

- **Regression analysis to evaluate relationship between gamma count and moisture content from soil samples**
  The study included development of complex computer code (script) in R which would go through the data files received from the client, make a master database and perform regression analysis for each borehole and report regression equation, r-square values by soil type. The code was written to even automate generation of graphics in png format.
- **Preparation of MODFLOW model for seepage analysis across proposed bulk head design**
  The study included generation of MODFLOW numerical model to estimate seepage velocity across proposed bulkhead and barrier pillars.
- **Preparation of MODFLOW model to predict future inflow to an underground coal mine**
  The study included a large 9 layer numerical model to estimate flow in an underground mine. Drain package was used to simulate mine voids in the study.

- **Bioreactor design for selenium treatment**
  Mr. Basu has completed several projects involving engineering design and selecting treatment criteria for selenium. These projects typically involve a lot of weir data collection to quantify flow and also a lot of geochemical data collection for selenium and other parameters to quantify metal loadings.
- **Analysis of Potential Seepage between Mines in West Virginia:**
  A mining company wanted to know about the seepage rate between two coal mines in the same seam separated by a thick barrier pillar**.** Water from the down-dip mine was to be pumped raising the difference in head between the two mines. Mr. Basu prepared conceptual groundwater model with flow-nets and calculated potential seepage through the mine barrier.
- **Investigation of Mine Water Storage and Recharge Potential, for Preparation Plant Supply**
  A study of groundwater storage capacity and recharge potential was performed in order to evaluate the potential for the water from an old coal mine to serve as a viable water source for a proposed preparation plant during seasonal dry periods. The investigation included estimation of the reservoir volumes available for water supply and the rate of recharge to the old coal mine. The study included a 72 hour pump test with four monitoring wells collecting continuous data in transducers.
- **Determination of Probable Hydrologic Consequences of Mining**
  Probable Hydrologic Consequences is a part of mining permit applications and Mr. Basu has been involved in many of such projects.
- **Inflow to Shaft / slope**
  Prediction of inflow to a shaft or a slope during construction and advancement is of vital importance. Such projects typically involve drilling of core-holes, geotechnical logging, conductivity testing and prepared mathematical model and ultimately recommendation for

grouting. Mr. Basu has completed numerous straddle-packer tests and prepared hydrologic mathematical models to predict inflow based on conductivity and thickness of various strata.

- **Stream-flow Evaluation of the Mine Discharge**
  Stream flow evaluations are very useful when searching for a fracture feeding inflow to a nearby mine. A significant loss of flow could be noticed if the fracture is connected to the stream. Mr. Basu has completed several stream-flow evaluation studies and successfully identified location of fractures.

- **Contour mapping and flow direction**
  Mr. Basu has prepared contour maps and assigned flow directions for various projects.

Geochemical Investigations

- **Leach test evaluation for lime amendment**
  Mr. Basu developed computer codes to evaluate leach test data to evaluate pyrite oxidation. Computer codes were generated to automate data visualization and performing statistical evaluation.

- **Water Mixing Analysis for various streams in West Virginia.**
  Geochemical models are very useful to predict concentration of metals after mixing of waters from various discharge points. Mr. Basu has used Geochemist's Workbench and PHREEQC to prepare Eh-pH diagrams, solubility diagrams and estimated equilibrium concentration of various dissolves species.

- **Determination of lime application rate to offset acid mine drainage**
  Mr. Basu has prepared geochemical models to assess the relative rate of calcium carbonate depletion verses pyrite oxidation.

- **Overburden characterization - Acid Base Accounting (ABA), Paste pH and Selenium**
  Mr. Basu has conducted several projects involving overburden characterization, identification of the acid producing zones and the selenium rich horizons.

- **Speciation Modeling for iron**
  A mining company needed a speciation model for iron as a part of a Probable Hydrologic Consequence (PHC) study. Mr. Basu prepared Eh-pH diagrams based on geochemical data from old existing mine pools from the same general area to predict the geochemical speciation of iron using Geochemist's Workbench. The client was successful in meeting regulatory requirements for the permit application.

Geotechnical Investigations:

- **Borehole Geotechnical Logging – RQD, Fracture Log**
  Basu has supervised drilling and prepared geotechnical logs including geologic, geotech and fracture (RQD) logs; geotechnical evaluations also include sampling for strength analysis.

- **Hydrogeological and Geotechnical Investigation of Mine Advancement Location beneath a creek**

A mining company planned to advance a mine beneath a stream at shallow depth to access remaining mineral reserves. Mr. Basu conducted hydrogeological and geotechnical investigation of the site to determine feasibility, potential consequences, and precautionary measures needed for the advancement.

- **Mine roof and Roof-bolting Evaluation of coal mine in Wyoming County, West Virginia.**
An underground coal mining company wanted to evaluate the length of roof bolts required to safely operate the mine. Mr. Basu visited the mine and recorded lithology and fractures in the roof using a borescope. The client successfully resolved the safe length of roof bolt for the coal mine following the study.

Mineral Reserve Studies

- **Exploration and supervision for mineral resources**
Mr. Basu has completed several projects involving planning, field supervision and management of exploration drilling for multiple clients in the states of VA, WV, KY, TN, PA and OH.
- **Geophysical Interpretations**
Mr. Basu has completed interpretation of hundreds of wireline geophysical logs of various kinds – gamma log, density logs, temperature logs, caliper logs, fluid-conductivity logs, resistivity logs, acoustic televiewer logs etc. Such logs are essential in identifying contacts and depths to target minerals like coal; identifying weak zones/fractures and aquifers.
- **Geological Study and Coal Reserve Evaluation**
Mr. Basu has performed correlation of coal seams, prepared reserve maps, structure maps, overburden maps, roof and floor maps, and interval maps between coal seams etc. Such projects involved preparation of digital database, preparation of 3D geologic model in Carlson Software and preparation of coal reserve tonnages. Mr. Basu also evaluated coal quality for designating metallurgical or steam coal.
- **Audit of Coal Reserve Tonnage:**
Mr. Basu has audited several reserve and resource studies completed by other consultants.
- **Verification of In-mine coal Measurements.**
A mining company was required to pay taxes based on coal seam thickness; Mr. Basu visited underground coal mine to verify coal thicknesses and defined bone and shale partings within the seam.
- **Documentation of Limestone Exploratory Drilling and Results**
A limestone quarry wanted to extend their reserve-base; Mr. Basu prepared geologic log of the limestone core samples; conduct sampling; and performed correlation of oolitic limestone horizons.

Landfill

- Performed environmental site assessment and investigations on natural contaminants
- Supervised monitoring well installations and abandonment.
- Conducted sampling in compliance with environmental permits issued by various Federal, State and local regulatory agencies.

- Performed statistical data analysis and prepared annual reports.
- Prepared potentiometric maps
- Prepared Eh-pH diagrams and performed speciation calculations using PHREEQC and Geochemist's Workbench