Kevin M. Andrews

Current Position

Vice President,
Manager Western
Mining Operations

Profession

Geology,
Hydrogeology,
Mining Engineering

Years' Experience

15

Education

MS – Mining & Minerals Engineering,
Virginia Polytechnic & State University,
Blacksburg, VA

MS – Geology,
West Virginia University,
Morgantown, WV

BS – Geology,
Juniata College,
Huntingdon, PA

Professional Registrations

Certified Professional Geologist (C.P.G.)

Affiliations

Member of American Institute of Professional Geologists (A.I.P.G.)

Summary of Experience

Mr. Andrews performs geological, hydrogeological, and engineering work. Specifically, he:

> Authors and prepares proposals, cost estimates, and technical reports for geological, geotechnical, and hydrogeological projects
> Conducts business development activities
> Conducts rock slope stability assessments for open pit mining
> Conducts geological field mapping and evaluation of geological discontinuities associated with open-pit mine slope stability and mineral exploration
> Collects geological and geotechnical logging data including fracture frequency and Rock Mass Rating (RMR) information
> Utilizes Rocscience programs such as DIPS, Swedge, RocPlane, RocTopple, and SLIDE for slope stability assessment
> Evaluates aspects of underground mine roof, rib, and floor stability (hard rock, aggregate, and coal) via underground observations, engineering concepts, and modelling programs
> Utilizes NIOSH programs including SPILLAR, ARMPS, ALPS, AMSS, CMRR, etc. to design and assess the stability of underground mine workings
> Uses the Surface Deformation Prediction System (SDPS), a land surface subsidence modelling program, to predict mine subsidence and assess long-term landscape stability
> Analyzes underground mine pillar stability, including stepped models of retreat coal mining and/or longwall advance using LaModel, a boundary element stress-modelling program
> Analyzes underground excavation stability using Examine2D (Rocscience) and evaluates results from FLAC3D stress modeling
> Assesses potential impacts of mining on hydrogeological environments
> Conducts numerous aspects of mine permitting-related work
> Evaluates groundwater and surface water conditions
> Conducts Probable Hydrologic Consequences (PHC) assessments
> Assists with the preparation of definitive feasibility and pre-feasibility geology and hydrogeology evaluations for proposed mine complexes
> Evaluates water volumes in inundated underground mines
> Assesses water balance issues associated with surface and underground mining activities
> Investigates mitigation options for mining-related selenium water discharges
> Assesses hydrogeological issues related to litigation matters
> Conducts mine barrier pillar stability and seepage assessments
> Works with staff to develop groundwater flow models using modeling programs such as Groundwater Vistas (MODFLOW) and AnAqSim
> Conducts yield testing and water sampling field work, and evaluates mining effects on water well conditions

Summary of Experience (Continued)

- Plans and supervises mineral exploration field activities (domestic and international); drill rig and field geologist management, data collection quality control, core recovery confirmation, geophysical logging scheduling, site preparation and reclamation, access road maintenance, etc.
- Develops mineral exploration drilling and mapping database files
- Contributes to mineral valuations to meet Australasian Joint Ore Reserves Committee (*JORC*) and US Securities and Exchange Commission (*SEC*) regulations

Professional History

2017-Present

Vice President, Manager of Western Mining Operations

Marshall Miller & Associates, Inc.

- Coordinate western United States project work
- Coordinate mining geotechnical projects

2015 – 2016
2012 – 2015
2008 – 2012

Manager Western Mining Operations / Sr. Engineering Geologist
Sr. Geologist/Graduate Engineer and Geologist

Cardno, Inc.
Marshall Miller & Associates, Inc.

Work as Geologist for Mining Advisory Services and Hydrogeology Group on projects involving:

- Planning and field supervision of coal exploration activities (USA and Australia)
- Geotechnical assessment of open pit and underground mining
- Geological and geotechnical logging, and data collection for coal exploration
- Coal reserve and resource estimation (JORC and SEC standards)
- Geological mapping and modeling utilizing Carlson software
- Hydrogeologic field work including acid-base account (acid-producing potential) sample selection, monitoring well installation, hydraulic conductivity (packer) testing, water sampling, and water user inventory data collection (USA and Australia)
- Definitive Feasibility and Pre-feasibility geology/hydrogeology evaluation for proposed mine complexes (Australia and Turkey)
- Assessment of underground mine roof, rib, and floor stability – field observations, data collection, and evaluation
- Stress modeling and analysis for underground coal and limestone mine design and pillar stability involving various programs including LaModel, Examine2D, FLAC3D, and NIOSH programs (ARMPS, ALPS, etc.)
- Groundwater modelling of longwall mining scenarios using Groundwater Vistas (MODFLOW)
- Geotechnical and hydrogeological assessment of underground coal mine pillars and barrier pillars regarding bulkhead design and construction (seepage and piping analyses)

2006 - 2008

Graduate Teaching Assistant / Graduate Research Assistant – Mining Engineering

Virginia Polytechnic and State University

Assist with teaching of undergraduate Energy and Mineral Resources class and management of student grades at Virginia Polytechnic and State University; assist with research on underground mine subsidence and horizontal stress issues.

2002 - 2006

Geologist

Marshall Miller & Associates, Inc.

Perform and assist with geological consulting including:

> Core drilling rig management (coal exploration and landfill expansion) and rotary drilling rig management (monitoring well installation)
> Detailed core logging (geotechnical and geological/geochemical) and mine soil logging
> Coal reserve studies and audits
> Field reconnaissance for abandoned mines, subsidence (natural and mining related), slope stability, water quality/quantity, stream loss, soil contamination, and flood analysis
> Monitoring well installation/pump tests; packer testing; dye trap collection and handling; and well/stream water sampling (with flow measurements) associated with refuse piles, acidic seeps, and mine drainage locations
> Stream mitigation design fieldwork and preparation of compensatory mitigation plans
> Coal mine permit work (water user inventory studies and stream delineation)
> Small-scale electromagnetic conductivity surveys
> Bio-remediation/natural attenuation enhancement fieldwork
> Periodic and residual coal-bed methane measurements.

2000 - 2002

Graduate Teaching Assistant – Geology

West Virginia University

Teach undergraduate Geology laboratory classes and manage student grades at West Virginia University.

1998 - 2001

Assistant Geologist (Summer Intern)

Work as intern geologist assisting with projects involving:

> Slope stability, mass wasting, and flood conditions following major precipitation events
> Coal reserve and audit studies
> Coalbed methane desorption measurements
> Geophysical logging data entry

Significant Projects

Hydrogeology

> Conducted detailed field reconnaissance and documentation of all potential hydrogeological and geotechnical effects of previous extensive underground and surface mining along segment of proposed interstate corridor.
> Conducted observations of surface water conditions and water well yield/quality testing to assess the potential for underground mining activities to have affected a hydrogeological system in West Virginia; work with a principal hydrogeologist to prepare text and exhibits to be presented in court.
> Part of a team of hydrogeologists to collect data and evaluate the potential for impacts to surface water and groundwater with regard to a large proposed underground coal longwall mine in northern West Virginia.

Significant Projects (Continued)

- Evaluated the water storage volume available in a complicated series of deep underground, abandoned mines.
- Worked with a team of hydrogeologists to implement an organic contaminant remediation plan utilizing techniques to enhance natural attenuation effects.
- Worked with Australian hydrogeological consulting firm to conduct field tests and create the physical layout of a MODFLOW model for a proposed open-pit mine in Australia
- Worked with a group of hydrogeologists to create a MODFLOW model to estimate mine inflow rates associated with a proposed longwall mine in Illinois, USA.
- Evaluated expected seepage rates associated with a proposed water-retaining bulkhead in an underground coal mine.
- Conducted hydrogeological field work for numerous years including strata hydraulic conductivity testing, surface and groundwater sampling, monitoring well installation, water well yield testing, and aquifer pump testing.

Geotechnical Assessment

- Proposed and implemented multiple geotechnical field investigations utilizing Acoustic Televiewer (ATV) and sonic down-hole geophysical logging tools to assess rock slope stability for proposed pit walls in planned pit expansion areas.
- Conducted assessment of open pit mine stability in Alabama, California, Utah, and North Carolina.
- Conducted field observations, including discontinuity measurements, in an underground coal mine in Colombia, South America; used the observations and other available information to evaluate mine roof stability issues and assist client with future mine planning.
- Predicted surface subsidence and associated ground strain for an advancing longwall coal mine in northern West Virginia to assess potential effects on houses, ponds, roadways, and other surface structures.
- Worked with mine personnel to design a basic monitoring plan for potential mining-related far-field horizontal subsidence movements associated with longwall coal mining near a large dam and reservoir.
- Worked with a client to design a stable underground coal mine layout for additional mining to be conducted in a very complex environment including deep cover (>1000 feet), large adjacent longwall mine panels, and overlapping multiple seam stress effects; The project involved assessing the stability of multiple iterations of mine layouts using LaModel, a boundary element stress analysis program. The layout and associated model was accepted and approved by the technical support group of the Mine Safety and Health Administration (MSHA).
- Used available information, analytical assessment techniques, and numerical modelling techniques to assess the long-term stability and potential for subsidence damage from a proposed mine passing beneath an existing major roadway; the assessment included underground mine floor stability evaluation using the Vesic-Gadde and Vesic-Speck approaches.
- Conducted detailed geotechnical logging of roof and floor rock and used the data to assist with evaluation of expected entry stability for a proposed longwall mine in northern West Virginia.
- Collected underground mine field observations, including discontinuity orientations, for an active mine in a 30-degree dipping limestone bed in Tennessee, USA; used the field observations to work with geotechnical specialists to optimize the layout of the mine; the project involved both analytical and numerical modelling (Examine2D and FLAC3D) assessment of the stability of the mine.

Significant Projects (Continued)

> Worked with the creator of LaModel, an industry-standard stress modelling program, to analyse pillar stability during retreat mining conditions in a deep coal mine where a suspected coal "bump" occurred.

> Collected field observations and publication research to investigate the cause of roof falls in an abandoned underground limestone mine being used as a storage facility in Kansas City, Missouri.

> Evaluated the stability of coal pillars and potential for piping failure associated with a proposed bulkhead/mine seal site; the proposed bulkhead will impound water from entering an active portion of the existing longwall mine.

Mineral Exploration

> Managed field activities (multiple diamond core drilling rigs, site preparation and reclamation, land owner communication, access road maintenance, geophysical logging scheduling) and geological logging/data collection for a year-long mineral exploration drilling project for a proposed longwall mine in northern West Virginia; currently conducting ongoing subsidence evaluation for the now active longwall mine.

> Conducted on-site data collection and quality control assessment for mineral exploration drilling activities in northwestern Australia; lived on-site in remote exploration camp working with field geologists to collect geological, geotechnical, and hydrogeological data required for preparation of a JORC resource report and a definitive feasibility report for the proposed mine.

> Managed field activities for coal exploration drilling to collect geological and geotechnical data for proposed mine site in northwestern Australia; lived on-site in remote exploration camp managing field geologists, proofing geological and geotechnical logs, correlating ongoing results of drilling, planning and managing site preparation/reclamation, working with camp manager to conduct regular safety talks and equipment maintenance, conducting exploration reconnaissance of future drilling areas.

Continuing Education Classes & Seminars Attended

> Acid Mine Drainage Task Force Meeting, Morgantown, West Virginia, multiple years

> Completed Natural Stream Mitigation Courses from WVU in collaboration with ACEC of West Virginia Courses completed include:
  - Part 1- Introduction to Stream Processes and Functions
  - Part 2- Methods for Stream Channel Assessment and Analysis
  - Part 3- Introduction to Natural Channel Design
  - Part 4- Advanced Natural Channel Design

> International Conference on Ground Control in Mining, numerous years (Presenter and Attendee), Morgantown, West Virginia

> Fundamentals of Professional Engineering, Virginia Polytechnic and State University, Blacksburg, Virginia, Spring 2010

> American Exploration & Mining Association (AEMA) conference – 2015-16 (Booth, Presenter)

> American Rock Mechanics Association (ARMA) Conference – 2016 Presenter

Thesis & Publications

> Andrews, K. (2008) Enhancing Mine Subsidence Prediction and Control Methodologies for Long-Term Landscape Stability, *Thesis submitted to Virginia Tech for Master of Science in Mining & Minerals Engineering*, Blacksburg, VA, 242 pages.

- Andrews, K. (2003) A Geological and Geophysical Investigation of Ice Mountain Algific Talus, Hampshire County, West Virginia, *Thesis submitted to West Virginia University for Master of Science in Geology*, Morgantown, WV, 77 pages.
- Karmis, M., Agioutantis, Z., and Andrews, K. (2008) Enhancing Mine Subsidence Prediction and Control Methodologies, 27th International Conference on Ground Control in Mining, Morgantown, WV, 131-136.
- Andrews, K. and Dockweiler, P. (2016) "Improvements in Data Collection for Geotechnical Pit Slope Stability Assessment" – American Rock Mechanics Association (ARMA) - Presentation and Paper
- Andrews, K. and Dockweiler, P. (2016) "Data Collection via Downhole Geophysical Logging Techniques for Open Pit Slope Stability Assessment and Resource Exploration", American Exploration and Mining Association (AEMA) – Presentation
- Kite, J.S., Andrews, K., and Wilson, T. (2003) Algific (Cold-Air Producing) Talus at Ice Mountain, West Virginia, USA: Structure and Dynamics of a Rare Central Appalachian Ecological Refugium, *XVI INQUA Congress*, Reno, Nevada, Paper No. 2-9.