Invited Keynote Lecture

A BRIEF OVERVIEW OF GEOLOGICAL ENGINEERING AND WHERE THE PROFESSION IS HEADED

for the national symposium on

Visioning the Future of Engineering Geology: Sustainability and Stewardship

Annual Meetings of the
Association of Engineering Geologists
American Institute of Professional Geologists

Reno, Nevada September 26, 2002

J. DAVID ROGERS

Karl F. Hasselmann Chair in Geological Engineering

University of Missouri-Rolla, Rolla, MO 65409

INTEGRATION OF GEOLOGY AND CIVIL ENGINEERING

- Karl Terzaghi (1883-1963) was widely recognized as the father of soil mechanics and foundation engineering
- He took classes in geology while studying mechanical engineering at the University of Graz between 1900-1904.
- In 1905 he translated Geicke's *Outlines of Field Geology* into German
- In 1906-07 he took post-graduate courses in geology after suffering a mountain climbing accident.
- In 1910 he began writing pioneering articles about the impacts of geologic site conditions on engineering projects.

Terzaghi's Influence Pivotal

- In 1929 he co-wrote the text **Engineering Geology** (in German) with K.A. Redich and R. Kampe
- Terzaghi took the title **Lecturer in Engineering Geology** at Harvard University in the fall 1938
- He was the only person to ever receive the **Norman Medal** from ASCE on four different occasions
- He advocated the **teaching of engineering geology** to all civil engineers

ENGINEERING GEOLOGY ADDED TO CIVIL ENGINEERING CURRICULUMS

between 1955-1980

- The Engineering Council for Professional Development (ECPD) was established in 1932 to oversee accreditation of collegiate engineering programs
- The post World War II era saw unprecedented expansion of the country's engineering infrastructure, with increasingly challenging projects.
- Under Terzaghi's influence, ECPD promoted adoption of engineering geology in "model civil engineering programs" at Harvard and MIT in the early 1950s
- By 1975, approximately 77% of the accredited CE programs required a course in engineering geology

QUALIFICATIONS-BASED SELECTION (QBS)

- QBS procedures were developed by the Army Corps of Engineers to select civilian engineering and architectural consultants during World War II
- The Brooks Act codified QBS procedures for selection of architectural and engineering services by federal agencies in 1972
- Mini-Brooks Acts were subsequently adopted by 35 states and most of their municipal agencies

QBS PROCEEDURES NOT USED FOR GEOSCIENCES

- The **Brooks Act** ONLY applies to Architectural and Engineering services, which require professional licensure to practice

- Since geology and allied natural sciences do not require professional licensure in **all 50 states**, many agencies decided they were **not bound** to QBS procedures for selecting geoenvironmental services

- EPA has never used QBS, instead they have been at vanguard of promoting **competitive bidding** for awarding contracts

THE “GEOENVIRONMENTAL REVOLUTION”

- **The Resource Conservation and Recovery Act** (RCRA) was enacted by Congress in 1976
- It mandated management of **solid** and **hazardous waste**
- In 1984 RCRA was amended to extend authority over siting, construction and monitoring of 2 million **underground storage tanks**, mostly from existing gas stations
- This created an unprecedented demand for geoenvironmental services

BID SHOPPING

- EPA's example of bid shopping geoenvironmental services rapidly spread to other governmental agencies
- In 1993 and 1994 Qualifications Based Selection narrowly survived elimination by the Federal Streamlining Acquisitions Act. It was preserved through effective lobbying by ASCE and AIA
- USBR and USCOE have continued to employ QBS procedures in selecting their consultants

ABET REPLACES ECPD AND BEGINS TO POLL ASCE MEMBERSHIP

- In 1980 ABET replaced ECPD as the accreditation body for engineering curricula
- In the early 1980s ABET worked with ASCE to poll their members about value of civil engineering coursework
- At this time only 7% of civil engineers work in the geotechnical field, before the “geoenvironmental revolution” began in the mid-1980s

ENGINEERING GEOLOGY EXCISED FROM CIVIL ENGINEERING CURRICULEM

- The majority of ASCE's members ranked engineering geology as being of "low importance" in their everyday work
- This should not have come as a surprise, given the small percentage of CE's engaged in geotechnical work at the time
- ABET decides to eliminate engineering geology as a required course and changes it to an elective
- By 2000, engineering geology only required in 6% of the accredited CE programs nationwide

SHIFTS IN RESEARCH EMPHASIS

- Between 1975-2000 the **majority** of of faculty teaching engineering geology, geomorphology and field geology courses **were not replaced** when they retired
- In large part this was due to new emphasis on geoenvironmental work, replacing past emphasis on civil infrastructure construction
- **Research emphasis** parallel this trend, with new emphasis given to environmental and climatologic subject matter

ENGINEERING GEOLOGY IS CONTINUING TO EVOLVE

- The basic engineering infrastructure of the USA was largely constructed between 1920-1980
- Since 1970, an increasing emphasis has been placed on environmental concerns
- Tools and interpretive techniques in the geosciences have improved radically since 1970
- More and more geologic information is being pulled off the Internet in lieu of using real geologists to do site-specific field work

CHANGING MARKETPLACE

- Corporate giants dominate the solid waste marketplace; they began developing their own in-house staffs to replace consultants in the 1990s
- During this same interim, geoenvironmental work began to slow down as yank-a-tank jobs were completed
- Turn-key services, which include investigation, design and construction management, began to dominate SuperFund site clean-ups
- “Nationwide firms” promote perception of being capable of providing all manner of services at all locations

IMPACT OF CORPORATE TAKE-OVERS

- Most large firms join forces or are absorbed into one another in an attempt to create **full-service companies** with wide geographic coverage
- Big selling point is **experience** with regulators and ability to handled **varied job requirements** at any site, over a period of years
- The geotechnical services sector has gradually polarized into large mega-firms and countless sole proprietors and hourly (at risk) employees

INCLINATION TO ACCEPT GREATER RISK

- The economic prosperity of the 1990s created an atmosphere promoting increased **risk-taking**, at all levels of our society. People tend to associate increased risk with increased profit potential
- **Professional liability insurance** was increasingly perceived as backstop for sub par work in a competitive marketplace
- Promotion in large firms was increasingly tied to project profits; but impact of lawsuits on project managers is not significant unless they are shareholders

LIKELY IMPACTS ON PROJECT LONGEVITY

- Diminished project life triggers a series of hidden costs to society
- The 1990s witnessed an alarming trend towards refinancing of mortgages, extending payback terms from 30 to between 40 and 50 years
- Most buildings require major maintenance and upkeep expenditures when 25 to 35 years old

CONCLUSIONS

- An outgrowth of our increasingly competitive culture is owners and developers are more willing to accept deferred risks than ever before
- More and more engineering **decisions** are being based on less and less site-specific geotechnical information
- Lapses in site characterization have been successfully defended as unforeseeable “Acts of God” rather than negligence
- Market forces will continue to drive down site characterization costs

VISION FOR THE FUTURE

In the coming years engineering geologists will need to reinvent ourselves by showing engineers the new tools and techniques at our disposal that can provide safer projects with less long-term liability. Geoscientists should resist the temptation to sacrifice quality for cost, especially when we are entering an era of performance-based building codes. The lion's share of the risk should lie with those reaping in the profits, not their consultants.