

The Demographic Earthquake: How to address workforce capacity in mineral resources professions



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Asarco employee Robert Ramirez looks over stainless-steel plates coated with 200 pounds of 99.9 percent pure copper at the company's Silver Bell Mine. Asarco is looking to hire 250 to 300 employees through 2007.

David Sanders / Arizona Daily Star

COPPER RUSH IS STILL ON

Ariz. prospects don't dampen profit outlook

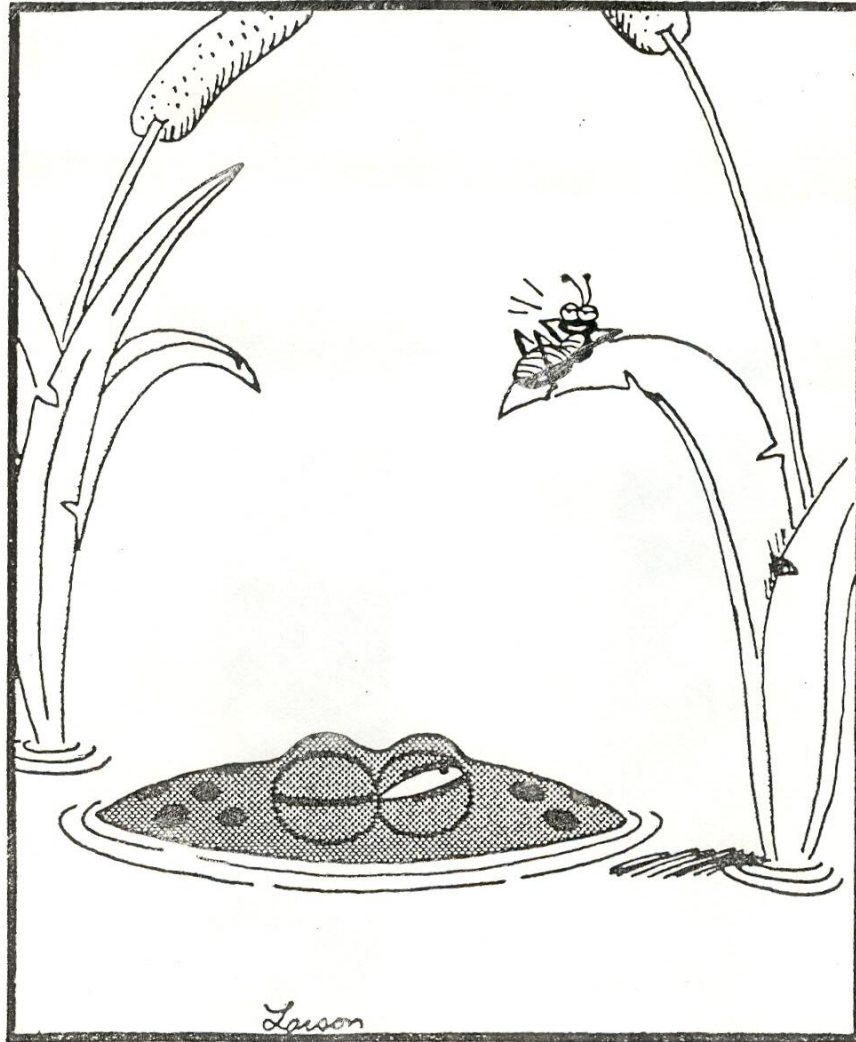
Price of gold gives new luster
to old Nevada mining town

Coal miners are hot commodity

Prior to 2007 We Focused on Undergrads

- 2001-2007 heavy focus by industry, SME, others on increasing undergraduate enrollment
 - SME Education Sustainability Task Force
 - Scholarships
 - Lucrative summer internships
 - Increased recruiting activities by companies
- Students responded to market forces and enrollment increased
- Job placements is outstanding; salaries are high

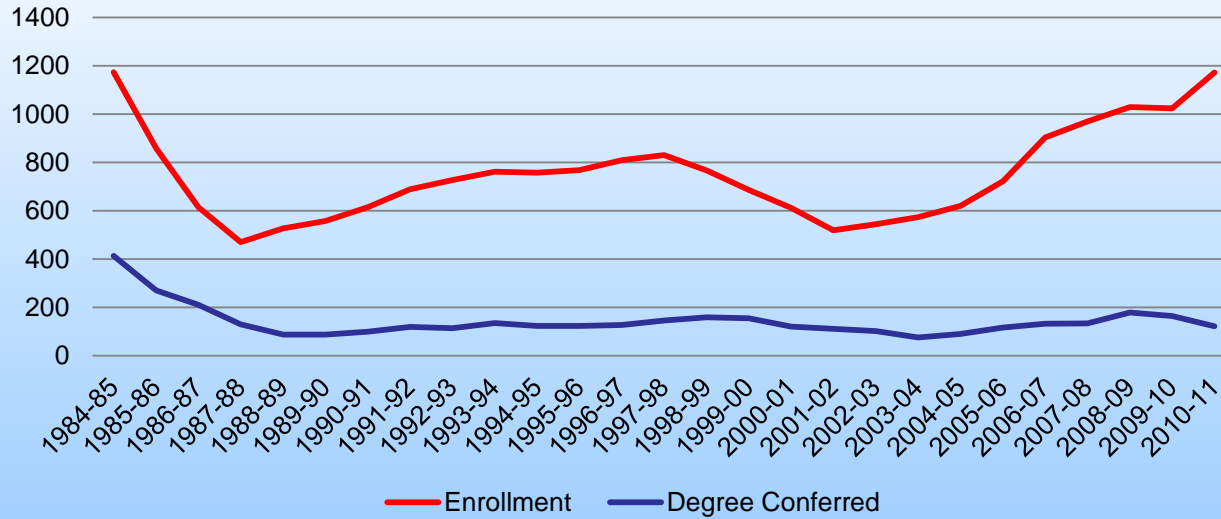




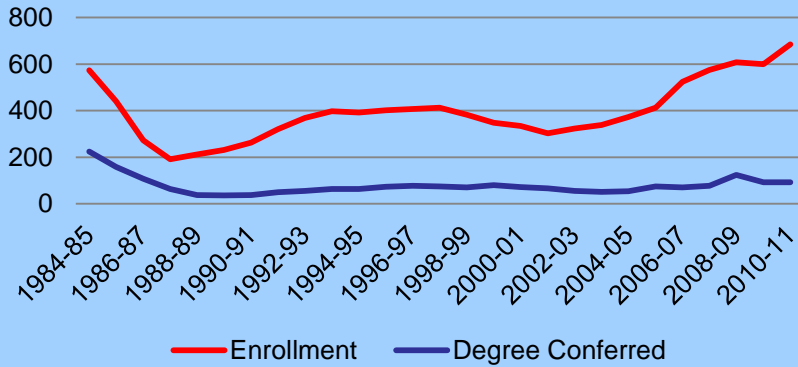
JULY
14
SATURDAY

"Ahhhh...life!"

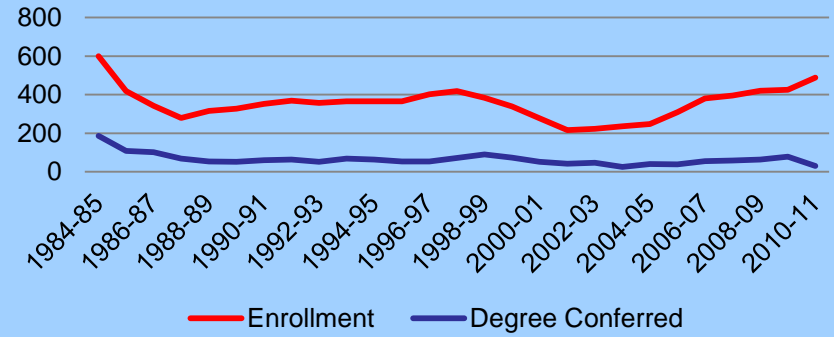
BSc Mining Engineering Total



East Total



West Total



The Competitive Landscape for Education

- Mining Engineering is a niche discipline
- Based on ABET accreditation for BSc degrees
- Fire protection engr 1
- Welding engr 1
- Telecom engr 2
- Survey engr & geomatics 6
- Marine engr/naval arch 8
- Construction engr 11
- Mining engr 13
- Nuclear engr 21
- Agricultural engr 36
- Bio/Biomedical engr 72
- Civil engr 225

The Game Has Changed (a bit)

- Pointed out the faculty demographic problem in context of research funding in 2004
- McCarter survey and paper in 2007 showed retirement trends
- Poulton survey in 2010 shows retirement trends and replacement cost
- Hiring pools of highly qualified PhDs for faculty positions are very thin
- Open positions are an easy budget cut



The Grand Challenge

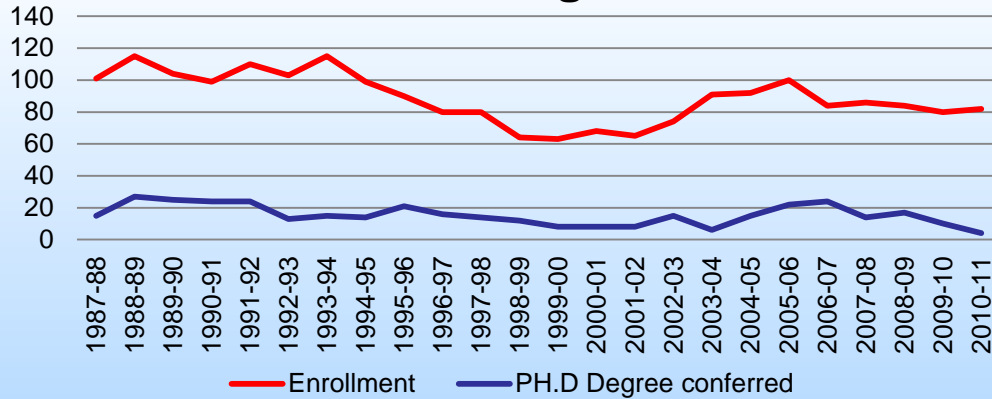


- Mining companies want mining discipline graduates
- Mining majors require mining programs/departments
- Mining departments require mining profs
- Mining profs require PhDs
- PhDs require research, \$, people
- But fewer metal mining companies make their profits in US – less support
- US federal R&D \$ is highly competitive

The Competitive Landscape for Research

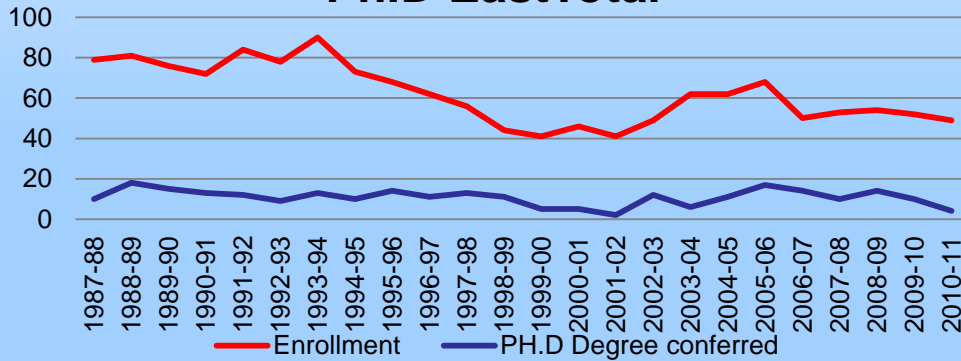
- 3,600 colleges and universities in US
- California has more colleges/universities than all but 6 countries in the world
- 236 doctoral granting institutions (top 20 universities get 30% of the funding)
 - 88 RI: \$40M/yr and 50 PhDs
 - 37 RII: \$15-39M and 50 PhDs
 - 51 Doctoral I: 40 PhDs in 10 disciplines
 - 60 Doctoral II: 10 PhDs in 3 disciplines
- Association of American Universities – top 60 research universities with quality depth and breadth
 - 82% of National Academy members associated with AAU universities
 - 74% of US Nobel Prize winners since 1999 at AAU universities
 - 63% of National Merit Scholars are at AAU universities
 - Penn State and UAz are only US AAU schools with mining engineering

Ph.D Mining Total



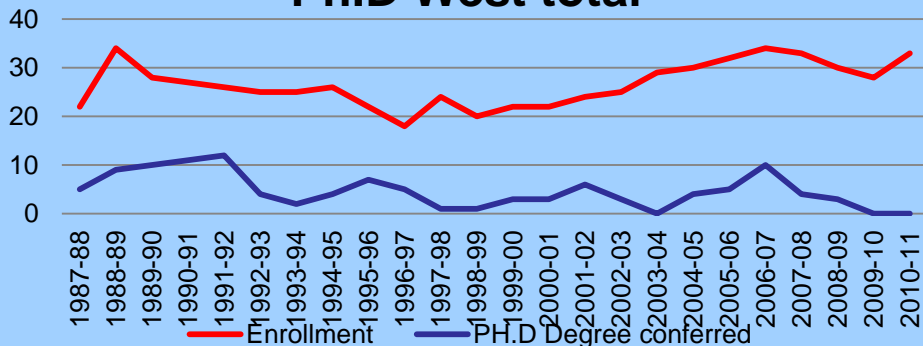
R1 Penn State	\$753M	#9
R1 VaTech	\$397M	#44
R1 Kentucky	\$373M	#49
R1 WVU	\$140M	#116
SIU	\$ 66M	#159
MS&T	\$ 35M	#200

Ph.D East Total



R1-Arizona	\$565M	#26
R1 -Utah	\$331M	#60
UA-Fairbanks	\$123M	#119
UN-Reno	\$106M	#126
NMT	\$ 82M	#145
CSM	\$ 40M	#189
SDSMT	\$ 14M	#258
Montana Tech	\$ 6M	#327

Ph.D West total



Rankings based on total 2009 R&D expenditures out of 711 institutions

Surveys

- Survey of 14 mining engr dept heads
- Survey of 6 metallurgical engr dept heads
- Survey of 74 mining and 24 metallurgical engineering graduate students
- April 2010 – August 2010 survey period
 - Questions reflected status during the 2009-10 academic year

Faculty - Mining

- 12 depts report 14 open searches
- 18 retirements in next 5 years
- 21 retirements in 5-10 years
- 9 lost in last 5 years to non-retirement issues

- 56% turn over in mining faculty ranks by 2020
- 100% of senior faculty can retire by 2020

Grad Students - Mining

- 88 PhDs (SME Guide) or 83 (survey)
- 86 MSc (SME Guide) or 97 (survey)
- 62 MEng (SME Guide) or 77 (survey)
- Total 231 (SME Guide) or 262 (survey)
- 22% response rate for PhD students; 18% for Master's students
- 88% male
- Average age 31 years
- 51% white;25% asian;14% Hispanic
- 51% are US citizens

Grad Students - Mining

- 75% have undergrad degree in mining engineering
- Avg time to complete PhD: 3.8 yrs (self reported)
- Avg work experience: 5 yrs prior to grad school
- 95% of PhD students would consider a university career at some point
- 6% have applied for an open position; 69% were graduating by end of 2011
- Expect a starting salary of \$71,000 for faculty position; \$83,000 in industry
- Only 1 respondent with a BSc in mining engineering east of the Mississippi River did graduate work west of the Mississippi River (many US students did not change universities)

Faculty Demographics

Year	Full Profs	Associate Profs	Assistant Profs	Vacancies	Total filled positions
2007 McCarter	41	22	7	10	70
2010 survey	36	23	10	14	69
SME Guide 2011	44	24	14		82

17 faculty members are older than 61
 10 faculty members are younger than 40

Cost of Faculty

- Average starting salary for assistant professors is \$70,166 with range of \$57,000 to \$80,000
- Average start up package is \$115,000 with range of \$40,000 to \$200,000
- Expect junior faculty to attract \$126,000 per year in extramural funding; range is \$60,000 to \$200,000
- Average funding expectation for tenured faculty is \$200,000
- Average salaries for associate professors is \$77,000
- Average salaries for full professors is \$90,000

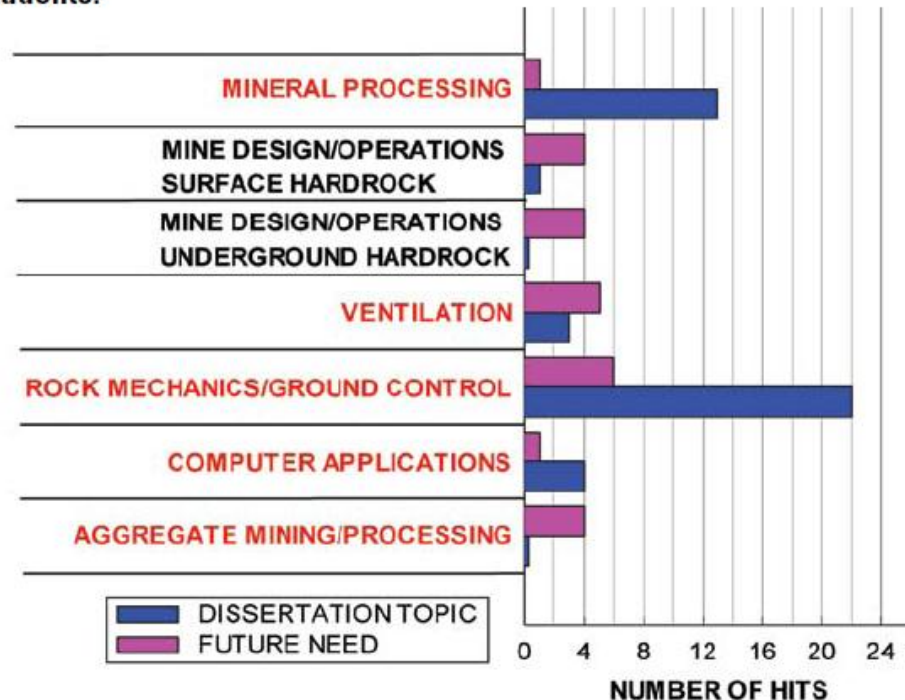
Research Capacity

- 5 departments teach 3 or fewer graduate courses per year (not cross listed with senior level)
- 2 departments teach 5-6 courses per year
- 3 departments teach 8 courses per year
- 3 departments teach 10 or more courses per year
- Cost of supporting grad students \$26-30,000 per year
- Expect assistant professors to complete 4 grad students prior to tenure
 - $82 \text{ faculty} \times 4 \text{ students} = 328$ full time grad students cf 182 current full time students
- Expect 9 peer reviewed journal papers prior to tenure

Do Market Forces Work for Grad Students?

FIGURE 11

Needed expertise compared to dissertation topics for current PhD students.



2007 McCarter Survey:
 Dept Heads idea of grad student specialties

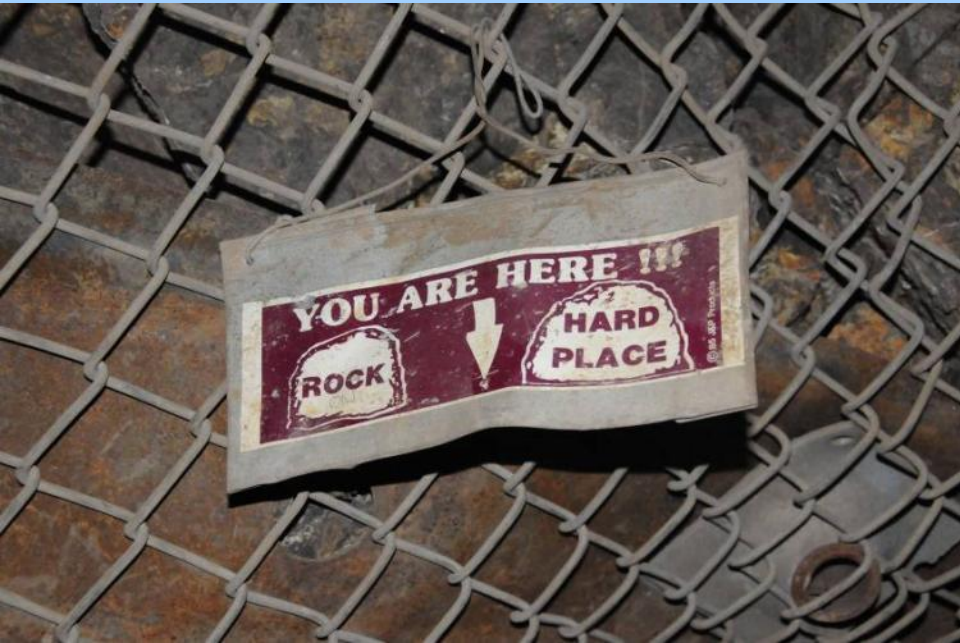
Do Market Forces Work for Grad Students?

- 2009 NIOSH allocated funding to ventilation; student numbers increased

Specialty	Number of students (from survey)
Mine design and planning	10
Processing	5
Explosives	4
Mine information technology/OR	6
Rock mechanics	8
Health and Safety	4
Ventilation	7
Finance, Valuation, Sustainability, Equipment	6

Scenarios

Acknowledgement to Steve Enders
for these scenarios



- **Wishful Thinking**
 - Super cycle will last a long time
 - Government will realize mining is important
 - Retirees want to teach
 - Industry and alums will donate \$
- **Steady State**
 - Let the market sort out the weak programs
 - International students fill grad programs
 - Industry benefits, ergo pays
- **Stealing with Pride**
 - Reinvent ourselves (oil model?)
 - Quality, fundamental education
 - Don't wait for gov't to help
 - Critical thinking skills

We Need a New Model

- Old Land Grant Mission
 - Teaching – Research – Service
- New Land Grant Mission
 - Opportunity – Innovation - Impact
- Look at impact not just enrollment
 - Industry support based on new mission
- Be entrepreneurial
- Be more interdisciplinary, less vocational
- Build public-private partnerships
- Self select a consortium of schools to collaborate on teaching/research
- Change the faculty model with private support (Professors of Practice + traditional faculty)
- More flexible grad degrees
- Exchange personnel between industry and academia
- Broader faculty backgrounds



IMR Workforce Capacity

Mining Firms Dig Deeper To Lure Scarce Workers

BY ROBERT GUY MATTHEWS

Demand for commodities has boosted the need for more miners around the world, prompting warnings from companies that a shortage could slow growth and increase costs.

The need for workers is forcing some companies, such as **BHP Billiton**, to prepare to fly workers to, and from remote mines. Others, such as **Rio Tinto**, say the shortage is accelerating efforts to automate oper-

ations. **Nittetsu Mining Co.** of Japan was forced to slow expansion plans to develop the Sol Naciente copper mine in Chile because of a shortage of miners. The miner says that it expects to pick up the mine's expansion plans by this spring.

Vale of Brazil, **Xstrata PLC** of Switzerland and **Anglo-American PLC** of Britain, along with **BHP** and **Rio Tinto**, are in the midst of expansion projects throughout the world in the hope of meeting demand fueled

by China, India and other developing countries. But some mining companies say the industry is facing increased competition for skilled workers from the oil and natural-gas industry, which is also ramping up spending for exploration and development.

While the scarcity translates into higher costs for mining companies, it benefits workers, who can move from one mine to another, seeking better pay and working conditions.

Kyle Hirsch, a silver miner in Big Creek, Idaho, left his job at the Lucky Friday mine, owned by **Hecla Mining Co.**, and started working at another nearby silver mine, which was paying \$350 more a week. "I have been a tramp all my life, going from mining job to mining job," says Mr. Hirsch, 44 years old, who now works as a driller at the Crescent Silver mine in Idaho. "Right now is a good time to mine. Mining is money."

Idaho-based **United Mining Group Inc.**, which owns an 80% interest in the Crescent Silver Mine, says it pays a two-person crew of miners about \$100 for every foot of rock they clear. Typically, a crew clears a depth

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Miners are finding better pay as mining companies compete for workers. Above, Hecla Mining's Lucky Friday silver mine in Idaho.

Develop a workforce pipeline through integration of research and education

485 total participants in IMR activities in 2011 to date

- 205 participants in projects
 - 35 faculty directly involved
 - 15 staff
 - 43 graduate students
 - 12 undergraduates
 - 3 post doc
 - 95 industry/gov't professionals
 - 2 high school students
- 75 construction workers (2010)
- ~280 IMR students in classes and short courses
- Graduated 13 GEOS and 4 MNE masters thru Aug '11
- 20 partner companies and nat'l lab
- 50 projects in progress or completed
 - Collaboration with NAU, ASU, UAF, CSM
 - Collaboration with national laboratory (Idaho)
 - Collaboration with NIOSH, USGS
- 135 publications and presentations since start in 2009

Workforce Capacity



Lowell Professional Programs in Mineral Resources

- Professional Science Masters in Economic Geology
- Master of Engineering in Mineral Resources
- Professional Certificate programs
- Lowell Field Courses (2)
- Lowell Short Courses (10)
- Interdisciplinary graduate courses
 - Environmental seminar
 - Mine vehicle automation
 - Topics in Mineral Resources
- >600 industry geologists and engineers have been involved in Lowell Program courses at the UA in the past 5 years
 - from > 51 companies and 22 countries