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DEVELOPING THE NEXT GENERATION OF LATINO LEADERS®

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An Emerging and Diverse Workforce To Reclaim Abandoned Mine Lands

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Introduction

The United States (U.S.) has a vast legacy of economic prosperity and innovative technological development stemming from its historic mining activities. Minerals recovered from our federal and public lands have been used to improve many facets of American life. These minerals provide vital ingredients in a wide range of everyday products that provide economic and national security. Unfortunately, another legacy associated with historical mining lies in its significant degradation of the environment (1, 2). More than a century of mining has created thousands of Abandoned Mine Lands (AML) sites with hundreds of millions of tons of solid wastes (3, 4). Today, estimates of abandoned mines near 500,000 in the United States (5). In 2015, Congressman Raul Grijalva from Arizona introduced legislation that would increase the funding to reclaim these inactive mines and it would reform the General Mining Law of 1872. The proposed Hardrock Mining Reform and Reclamation Act of 2015 (H.R. 963, 114th Congress) requires reclamation bonds for cleanup liability. This legislation could be improved if it took into account the need for a qualified and trained workforce in environmental and geosciences to reclaim abandoned mines. This paper identifies initiatives and programs that can be used to prepare the next generation of environmental scientists and geoscientists, while increasing the participation of underrepresented groups in earth science, particularly women and minorities. The policy recommendations will focus on providing academic access to these professions to Hispanics in the U.S. Southwest region where a critical need exists to restore AML sites through reclamation.

A National Environmental Justice Issue

AMLs exist across private, federal and state lands adding to the complexity of the issue. Environmental damage occurred because historic mining operations were not subject to our current environmental protection laws (e.g., the Clean Air Act (1963), Clean Water Act (1977), and Comprehensive Environmental response Compensation and Liability Act (1980). The issue of AMLs proves significant in Southwestern states of New Mexico, Arizona, Utah, Colorado, Nevada and California. A rapidly growing population in the Southwest continues to encroach on areas of historic mining activities, creating a greater potential for adverse effects to human health and the environment (6). These abandoned mines and associated mining wastes may pose both physical and chemical hazards; there is an increased exposure to people and risks of accidents and injuries from AML legacy sites (7, 8).

The typical kinds of environmental problems stemming from AML sites include: contaminated/acidic surface and ground water, and stockpiled waste rock and mill tailing piles (9, 10, 11). Highly acidic water rich in metals acts as a serious problem at many abandoned mines; they pose significant risks to surface water and ground water (12, 13). However, the potential chemical hazards vary greatly from one mine to the next. Each abandoned mine and associated mine waste piles need to be evaluated individually to determine the risk. In addition, the physical hazards are the most common source of death and injury (14). These AMLs often contain structures, tunnels, and waste piles, which attract adventurous explorers who are usually unaware of the potential dangers (15).

Projected Workforce Trends

Geologists, soil scientists, environmental scientists, environmental engineers or other qualified professionals play a key role in the well-being of our nation and they can assist in AML reclamation activities. Employment of environmental scientists and specialists has been projected to grow 11 percent from 2014 to 2024, faster than the average for all occupations (Bureau of Labor Statistics) (16). Heightened public interest in the hazards facing the environment, as well as the increasing strains placed on the environment by population growth, will spur demand for environmental scientists and specialists. The geoscientist profession will also experience a growth in employment. From 2014–2024, predictions show that an additional 10 percent

Demand for workers at all levels will remain strong for the foreseeable future and these jobs will continue to pay well, the average median annual salary for geoscience-related occupations in 2013 was $83,311 (19).

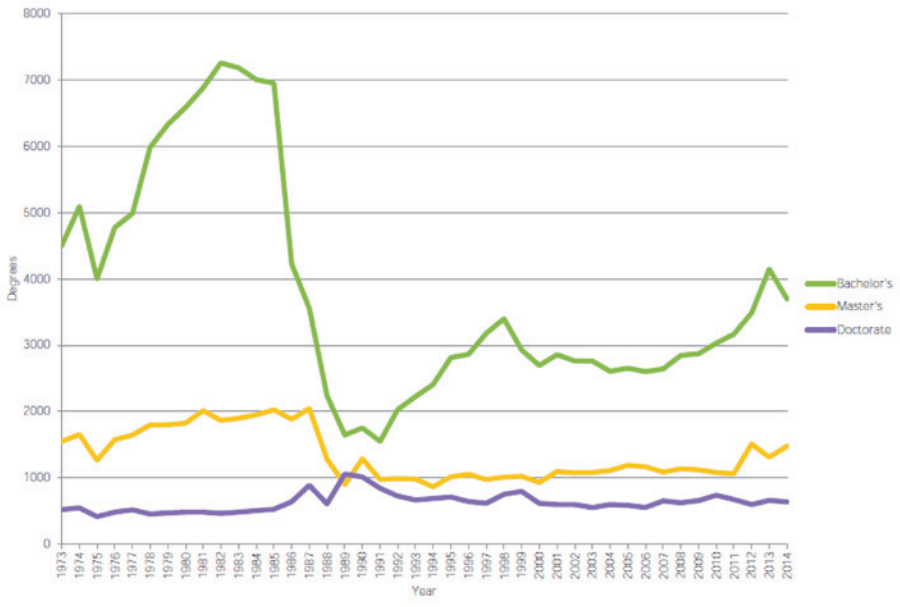
of geoscientists will be needed to meet employment demand (The Bureau of Labor Statistics) (17).

The need for environmental protection, and responsible land and resource management is projected to spur demand for geoscientists in the future. According to data collected by the American Geological Institute, the geosciences continue to be a lucrative employment option within the current workforce (18). Demand for workers at all levels will remain strong for the foreseeable future and these jobs will continue to pay well, the average median annual salary for geoscience-related occupations in 2013 was $83,311 (19). In an economic climate where other professions will experience a decline in demand, the number of mining jobs will increase that include AML reclamation (16, 17, 18).

Participation of Women and Underrepresented Minorities

Women have made substantial gains in the environmental science and geosciences fields over the past several decades, and now they hold almost a quarter (24.5 percent) of these professions in 2014 (Department of Education) (20). However, compared with women, the gains of underrepresented minorities in environmental science and geosciences have been modest, less than 12 percent of the workforce identified as Black or African-American, Asian, or Hispanic or Latino (Department of Education) (21). Regardless of field, women, who make up 50.8 percent of the U.S. population, have made substantial gains in secondary education over the past several decades and now receive between 57 and 58 percent of bachelor's degrees (22, 23). However, the federal workforce—and the academic programs that produce graduates—does not yet mirror the ethnic, racial, and gender diversity of the U.S. population. For example, underrepresented minorities (African-American, American Indian, and Hispanic or Latino of any race) composed 29.8 percent of the U.S. population in the 2010 Census, but received only 9.3 percent of bachelor's degrees awarded in 2012 (22, 24).

Figure 1 U.S. Geoscience Degrees Granted 1973–2014



Trends in number of geoscience degree (defined in this figure as encompassing environmental science, hydrology, oceanography, atmospheric science, geology, geophysics, climate science, geochemistry, paleontology; environmental, exploration and technical engineering; and geoscience management) awarded at U.S. 4-year colleges from 1973-2014.

Source: Wilson (2014).

Academic Readiness of Hispanics

Hispanics comprise the largest minority group in the United States, making up roughly 17.4 percent of the country's population (55.4 million) in 2014 (22). According to a recent study by the Pew Hispanic Center, Hispanics now also represent the largest minority on college campuses, they make up roughly 19 percent of all U.S. college students ages 18 to 24 (25). Notably, over half of all Latino undergraduate students in higher education (62%) have enrolled in 13 percent of institutions in the United States identified as Hispanic Serving Institutions (HSIs) (26). HSIs are defined in federal law as accredited and degree-granting public or private nonprofit institutions of higher education with 25 percent or more total undergraduate Hispanic full-time equivalent (FTE) student enrollment (27). In 2014–2015,

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435 institutions existed that met the HSI enrollment criteria, and they enrolled 1.75 million undergraduates. Of the 435 HSIs, 172 offered graduate degrees (90 offered doctoral degrees as the highest degree, and 69 offered masters degrees) (28). Over 68 percent of HSIs are public degree-granting institutions, and they are located in 18 states and Puerto Rico (28). In addition, in 2014-2015, there were also 310 institutions that are identified as emerging HSIs, these institutions had between 15 and 25 percent undergraduate FTE Hispanic enrollment (29).

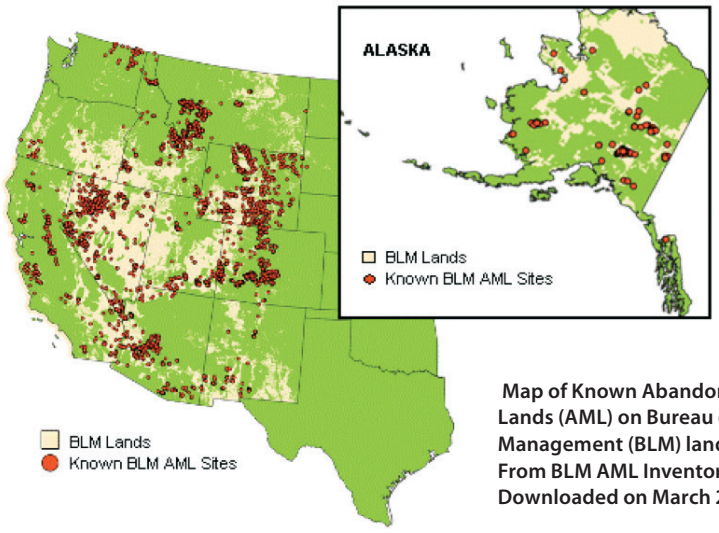
Training the Next Generation

Supporting a future pipeline of trained professionals that are capable of examining AML sites and their associated environmental, health, and safety issues proves critical. However, the number of graduates in these environmental and geosciences fields that can address this issue is decreasing, and lacks diversity. In 2013, about 40 percent of whites/Caucasians ages 25 to 29 had a bachelor's or higher, in comparison, just 15 percent of Hispanics among the same age group had a bachelor's degree or higher (30) As the Baby Boomer generation starts to retire, the United States will face the loss of a large number of experienced earth science and environmental science professionals in industry, academia, and the government. However, the current pipeline of STEM-capable students and workers proves inadequate to meet AML workforce needs (18). The National Academy of Sciences (NAS) published a report that stated that there is a growing demand for geosciences and engineering professionals by the mining and energy sector (31). The current educational system is not producing enough qualified workers to replace the retiring generation (18).

Training Programs

To help increase the number, quality, and diversity of the AML workforce, federal agencies and the private corporations that hire these professionals could invest in a variety of education and training programs that can attract and retain students in these fields. Educating the public about the importance of reclaiming AMLs and the career opportunities this sector offers future scientists is critical for Hispanics living in the Southwest. Efforts to broaden the participation of unrepresented groups in the workforce to reclaim abandoned mine lands are needed to address this pressing environmental hazard. Addressing these issues requires a skilled workforce that draws on the talents of all citizens, including women and minorities historically underrepresented in earth science and environmental sciences professions. Increasing the participation of minorities in these fields, will require not only effective practices within individual programs but also attention to linkages between programs and socioeconomic inequities such as uneven access to mentors or financial resources. Individuals should first be introduced to potential careers in the environmental and earth science field. Secondly, learning about the topics in the field and getting hands-on experiences. Finally, individuals should prepare for a career by acquiring specialized knowledge, skills, and expertise as well as by exploring different employment options. Concerns over pollution, environmental degradation, and health issues, can significantly influence Hispanics in the Southwest and across our country to pursue careers in earth science and environmental science to address AML reclamation. Today, an extensive number of abandoned mines exist on federal lands, as over 100,000 inactive legacy mines reside in the Southwest (Figure 2).

Figure 2



Map of Known Abandoned Mine Lands (AML) on Bureau of Land Management (BLM) lands only. From BLM AML Inventory website. Downloaded on March 21, 2014.

Programs that raise awareness of earth science or that increase access to education and training (e.g., social and professional networks, financial assistance for study) may be especially fruitful for federal agencies looking to increase diversity.

Overview of a Successful Training Model

Educational funding is limited, so it is imperative that agencies and industry model existing program that have been successful at attracting or retraining minorities and women in STEM fields. The Hispanics Leaders in Agriculture and the Environment (HLAE) program at Texas A&M University has been identified as a successful program that has increased the number of minority students graduating in STEM fields. This federally-funded program took a comprehensive approach that included the integration of students into college academic and social systems, that include the development of knowledge and skills, support, mentoring, monitoring, and advising. Unfortunately, this program ceased in 2012 due to federal budgetary constraints. The additional factors that were important for creating success for this program included the requirement of a research or training component (e.g., by providing research experiences to students) that stimulated interest through hands-on research and the development of student cohorts that provide mutual support. The HLAE program provided scholarships and stipends to master's and doctoral students to pursue career in agriculture and environmental fields; it also provided students the opportunity to network, by facilitating the student's participation in national conferences to present research results, social activities, peer-to-peer support, and mentoring programs. These professional preparation opportunities help socialize students within a discipline, promote academic success, and prepare them for careers. Recognizing and emulating this successful program could help realize great benefits. The creation of a similar program with a focus on preparing the next generation of Hispanic environmental scientists and geoscientists professionals in the AML workforce is needed for us to address this national workforce issue. These programs open doors of opportunity to underrepresented minorities, but they could also help attract and retain students of all backgrounds.

Additionally, studies suggest that a variety of interventions are needed to increase the participation of underrepresented minorities in the science, technology, engineering and mathematics (STEM) fields, including (a) research and internships experiences that expose student to real-world work hands-on experiences at the graduate and undergraduate level; (b) networking opportunities; (c) financial assistance to support undergraduate and graduate study to gain specialized knowledge, skills, and expertise; and (d) efforts to lower barriers to participation, such as developing outreach activities to cultivate future students (32).

Policy Recommendations

The information presented in this paper can be used by government, academic and professional society managers of earth science education and outreach programs. Recommendations to strengthen the diversity in the Abandoned Mine Land workforce include:

A. Amend the Hardrock Mining Reform and Reclamation Act of 2015 (H.R. 963, 114th Congress) to include education and workforce training opportunities that attract young people, including ethnic minorities and women, into STEM programs that lead to careers in the AML reclamation field, in environmental science and geosciences. Policy-makers should support university research that contributes to workforce development by enhancing the education pipeline.

B. Federal agencies should provide increased research funding to current and emerging Hispanic Service Institutions with environmental and geoscience programs (e.g. The University of Arizona, University of Nevada, Reno, and the New Mexico Institute of Mining and Technology), with matching funding from industry and specific requirements to incorporate two outcomes from the research: (1) advancing technology to drive innovation in AML reclamation, and enrich graduate and undergraduate education; and (2) developing university faculty who work on the cutting edge of AML research to enhance the quality of higher education.

C. Congress should provide the Department of the Interior (DOI) with legislative authority to support research-based programs to increase underrepresented student participation in STEM, with a focus on AML reclamation and direct DOI to establish a nation-wide pilot in partnership with the private sector. This goal could be achieved through the creation of a Long Term Ecological Research (LTER) Program on AML sites with funding from the National Science Foundation (NSF) in collaboration with DOI would be greatly beneficial to the field of land reclamation and to the future workforce. The goal of an LTER is to address ecological questions that cannot be resolved with short-term observations or experiments (37). These long-term interdisciplinary studies prove essential in achieving an integrated understanding of how populations, communities, and other components of ecosystems interact as well as to test ecological theory. Currently, 25 Long Term Ecological Research Programs exist; however, none

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of these programs address the issue of abandoned legacy mines.

D. Research programs that address AML reclamation can be used by agencies to identify potential partners and share effective practices for attracting and retaining traditionally underrepresented minority students. These industry-education partnerships can produce a STEM competent workforce in environmental science and geoscience fields. In particular, programs that raise awareness of earth science or that increase access to education and training (e.g., social and professional networks, financial assistance for study) may be especially fruitful for federal agencies looking to increase ethnic, racial, and gender diversity in the public-sector.

E. Federal agencies should promote collaborative efforts with industry and professional societies, focused on diversity to assist in connecting students to education and training opportunities, providing students with another avenue of information on available positions. Research experiences for undergraduates and paid internships provide students with technical and non-cognitive skills that improved communication, team work, project management and leadership. Another recommendation falls under the idea that any federally-sponsored programs adopt the use of peer and professional mentors; they can play a key role in providing information, guidance, and support at critical decision points in students' careers.

Conclusion

A strong and pressing need for a qualified and trained workforce in environmental and geosciences to reclaim abandoned mines exists, especially in the Southwest where more than 100,000 AMLs currently reside. This need presents significant opportunities for Hispanic students looking for a viable career with anticipated growth. This paper has identified initiatives and programs that can be used to prepare the next generation of environmental scientists and geoscientists, while increasing the participation of underrepresented groups in earth science, particularly women and minorities. Reinstating programs like HLAE and creating coalitions of partners from federal agencies, private companies, universities, and professional societies would stretch federal dollars and bring a wide range of expertise to training the next generation of earth scientists. Such efforts contribute toward meeting national goals of developing a robust and diverse STEM workforce.

Endnotes

1. Lottermoser, B. (2010). *Mine wastes: characterization, treatment and environmental impacts*. Springer Science & Business Media.

2. Dudka, S., & Adriano, D. C. (1997). Environmental impacts of metal ore mining and processing: a review. *Journal of environmental quality*, *26*(3), 590-602.

3. Allan, R. J. (1995). Impact of mining activities on the terrestrial and aquatic environment with emphasis on mitigation and remedial measures. In *Heavy Metals* (pp. 119-140). Springer Berlin Heidelberg.

4. Fields, S. (2003). The earth's open wounds: abandoned and orphaned mines. *Environmental health perspectives*, *111*(3), A154.

5. Fortin, D., Davis, B., Southam, G., & Beveridge, T. J. (1995). Biogeochemical phenomena induced by bacteria within sulfidic mine tailings. *Journal of industrial Microbiology*, *14*(2), 178-185.

6. Extent of Problem. Retrieved April 03, 2016, from http://www.abandonedmines.gov/ep.html. Bureau of Land Management

7. Duszak, Z., Koczkodaj, W. W., & Mackasey, W. O. (1993). Towards better abandoned mine hazard prioritizing-An expert system approach. In *The Challenge of Integrating Diverse Perspectives in Reclamation, In: Proceedings of the 10th National Meeting of ASSMR, Spokane, Washington* (Vol. 577, p. 589)

8. Culshaw, M. G., McCann, D. M., & Donnelly, L. J. (2000). Impacts of abandoned mine workings on aspects of urban development. *Mining Technology*, *109*(3), 132-139.

9. Woody, C. A., Hughes, R. M., Wagner, E. J., Quinn, T. P., Roulson, L. H., Martin, L. M., & Griswold, K. (2010). The mining law of 1872: change is overdue. *Fisheries*, *35*(7), 321-331.

10. Hossner, L. R., & Hons, F. M. (1992). Reclamation of mine tailings. In *Soil Restoration* (pp. 311-350). Springer New York.

11. Rösner, U. (1998). Effects of historical mining activities on surface water and groundwater-an example from northwest Arizona. *Environmental Geology*, *33*(4), 224-230.

12. Banks, D., Younger, P. L., Arnesen, R. T., Iversen, E. R., & Banks, S. B. (1997). Mine-water chemistry: the good, the bad and the ugly. *Environmental Geology*, *32*(3), 157-174.

13. Robb, G. A., & Robinson, J. D. (1995). Acid drainage from mines. *Geographical journal*, 47-54.

14. Bell, F. G., & Donnelly, L. J. (2006). *Mining and its Impact on the Environment*. CRC Press.

15. Culshaw, M. G., & Waltham, A. C. (1987). Natural and artificial cavities as ground engineering hazards. *Quarterly Journal of Engineering Geology and Hydrogeology*, *20*(2), 139-150.

16. *Occupational Outlook Handbook, 2016-17 Edition*, Environmental Scientists and Specialists. Retrieved April 03, 2016, from http://www.bls.gov/ooh/life-physical-and-social-science/environmental-scientists-and-specialists.htm. Bureau of Labor Statistics, U.S. Department of Labor

17. *Occupational Outlook Handbook, 2016-17 Edition*, Geoscientists. Retrieved April 03, 2016, from http://www.bls.gov/ooh/life-physical-and-social-science/geoscientists.htm. Bureau of Labor Statistics, U.S. Department of Labor

18. Keane C. M. (2011). Highlights of 2011: Jobs, jobs everywhere, but not enough people to fill them. *Earth Magazine*, *56*(12).

19. Wilson, C. E. (2014). 2013 Median Salaries for Geoscience-Related Occupations. *Geoscience Currents*, *91*.

20. Bureau of Labor Statistics, U.S. Department of Labor (2015), "Women in the labor force: a databook", (Report No. 1059).

21. Landivar, L. C. (2013). Disparities in STEM employment by sex, race, and Hispanic origin. *Education Review*, *29*(6), 911-922.

22. Population estimates, July 1, 2015. Retrieved April 03, 2016, from http://www.census.gov/quickfacts/table/PST045215/00. Census Bureau, U.S. Department of Commerce

23. National Center for Education Statistics, U.S. Department of Education and the Institute of Education Sciences (2012), "The condition of education 2012", (Report No. 2012-045).

24. Wilson, C. E. (2014). The Challenges of Comparing Data on Minorities in the Geosciences. *Geoscience Currents, 83*.

25. More Hispanics, blacks enrolling in college, but lag in bachelor's degrees, April 24, 2014. Retrieved April 04, 2016, from http://www.pewresearch.org/fact-tank/2014/04/24/more-hispanics-blacks-enrolling-in-college-but-lag-in-bachelors-degrees/. Pew Research Center

26. Number of Hispanic-Serving Institutions Continues to Rise. Retrieved April 04, 2016, from http://www.insightintodiversity.com/number-of-hispanic-serving-institutions-continues-to-rise/. Insight Into Diversity and Potomac Publishing, Inc.

27. Hispanic-Serving Institution Definitions. Retrieved April 04, 2016, from http://www.hacu.net/hacu/HSI_Definition.asp. The Hispanic Association of Colleges and Universities

28. *Excelencia* in Education (2016), "Hispanic-Serving Institutions (HSIs): 2014-15 at a Glance", Washington, D.C.

29. *Excelencia* in Education (2016), "Emerging Hispanic-Serving Institutions (HSIs): 2014-15", Washington, D.C.

30. 5 facts about Latinos and education, May 26, 2015. Retrieved April 04, 2016, from http://www.pewresearch.org/fact-tank/2015/05/26/5-facts-about-latinos-and-education/. Pew Research Center

31. National Research Council of the National Academies (2013) *Emerging workforce trends in the U.S. energy and mining industries: A call to action.* National Academies Press.

32. Committee on Underrepresented Groups and the Expansion of the Science and Engineering Workforce Pipeline, Engineering Committee on Science (and Public Policy), & Policy and Global Affairs. (2014). *Expanding underrepresented minority participation: America's science and technology talent at the crossroads*. National Academies Press.

33. Callahan, J. T. (1984). Long-term ecological research. *BioScience*, *34*(6), 363-367.