

Standing Committee on Engineering Geology (AFP10)
Ty Ortiz, Chair

Landslides and Beyond: A History of the Standing Committee on Engineering Geology

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OVERVIEW

Although the Standing Committee on Engineering Geology (AFP10) was established in 1970, it evolved from an earlier Committee on Landslide Investigations established in 1951. AFP10 has an extensive record of activities concerning the application of geological science principles to assess the influence of earth materials on civil engineering works for transportation infrastructure and the evaluation and mitigation of geologic hazards.

The committee has produced a series of four widely used publications on landslides and rockfall [1, 2, 3, 4]. In 1991, Rockfall Management Subcommittee AFP10(1) was established; it actively monitors and participates in the research and development activities of this rapidly evolving field. In 2018, the Advances in Landslides, Analysis, and Control Subcommittee AFP10(2) was established to evaluate the need, and to recommend the best future update, for the existing landslide report [3]. AFP10(2) expects to submit its recommendations to TRB staff in 2019.

With a full complement of active members representing a broad geographic and demographic distribution, and providing representation from state and national transportation organizations, consultants, contractors, academia, and international experts, AFP10 has been able to address additional aspects of engineering geology relevant to transportation infrastructure. AFP10 has an enviable record of collaboration with other TRB committees and entities and, with numerous outside national and international organizations, has sponsored or co-sponsored specialty conferences, symposia, workshops, and webinars. AFP10 has sponsored the publication of papers in many Transportation Research Records. Committee members also have authored numerous technical manuals produced by other organizations and participated in NCHRP and SHRP 2 panels and studies.

As discussed in the 2018 Triennial Strategic Plan, AFP10 plans to continue and expand these activities. It has recently updated the Committee Webpage to a more inviting, dynamic, and interactive format and now will add additional content to enhance its visibility and usefulness as an information source. The intent is to attract underrepresented groups and other nontraditional stakeholders to AFP10 activities by incorporating more online communication.

AFP10 recognizes there are important changes occurring in many aspects of geotechnical research needs and practice related to the design, construction, and maintenance of transportation infrastructure as the industry moves toward incorporating Geotechnical Asset Management (GAM) principles and data driven decision concepts. The forthcoming committee membership rotation provides an opportunity for AFP10 to expand its professional discipline makeup to include nontraditional stakeholders such as IT specialists, GIS and database programmers, data

visualization specialists, and planners. Additional subcommittees may be formed as required to assist AFP10 with these new topics by allowing for an expanded associated subcommittee membership base. New collaborations within and beyond TRB will also be pursued.

COMMITTEE ACCOMPLISHMENTS AND CONTRIBUTIONS

The contributions and accomplishments of the Engineering Geology Committee are most easily discussed in three time-periods. The first period begins with the establishment of the Committee on Landslide Investigations in 1951 and ends with the 2012 publication of *Rockfall: Characterization and Control* [4]. The second period defines recent AFP10 accomplishments between 2013 and 2018. The third period outlines the future plans and goals of AFP10.

Early Years (1951-2012)

The Highway Research Board (HRB) *Committee on Landslide Investigations* was established in 1951. Prior to this date, the HRB published only two identifiable papers dealing with landslides. A 1928 paper by Terzaghi [5] describes a graphical method for evaluating the stability of clay slopes and the use of retaining walls. This paper was published in an expanded format in the journal *Public Roads* in 1929 [5]. The 1947 Report of the HRB Committee on Roadside Development contained a short discussion by Neal [6] which stated “*The hazards of earth slides, erosion of slopes, blocking of drainageways, and interference of pole lines and trees stress the need for more liberal right-of-way widths and improved cross section grading and slope protection measures*”.

In 1970 the HRB Geology and Properties of Earth Materials Section within the Design and Construction of Transportation Facilities Group established the *Committee on Engineering Geology (A2L05)*. When HRB was renamed the Transportation Research Board (TRB) in 1974, A2L05 remained unchanged in name or position in TRB. However, after a restructuring of TRB in 2004, the committee became the *Committee on Engineering Geology (AFP10)* located in the Geology and Properties of Earth Materials Section of the Design and Construction Group.

Over these (almost) seven decades, the accomplishments of this series of committees has, in coordination with the goals of the parent HRB-TRB organization, gradually expanded from simply collating and sharing information, to developing a series of increasingly extensive internationally accepted reference publications on the stability of natural slopes, and successful research investigations.

As engineering geology topics have become integral in the design, construction, operation, and maintenance of transportation infrastructure, the committee has become more involved in collaborations with multiple national and international professional organizations, as well as other TRB committees and NCHRP and SHRP 2 research initiatives. Archival records have identified the following sequence of Chairs for the *Committee on Engineering Geology* from its initial formation to the present:

1. 1970-1976: David L. Royster, Tennessee Department of Transportation
2. 1976-1982: Robert L. Schuster, U.S. Geological Survey
3. 1982-1985: David L. Royster, Tennessee Department of Transportation
4. 1985-1991: A. Keith Turner, Colorado School of Mines
5. 1991-1997: Jeffrey R. Keaton, SHB Agra, Inc.
6. 1997-2003: John Duffy, California Department of Transportation
7. 2003-2009: Thomas Badger, Washington State Department of Transportation

8. 2009-2015: Lawrence Pierson, Landslide Technology
9. 2015- Present: Ty Ortiz, Colorado Department of Transportation

The Committee on Landslide Investigations 1951-1969

In 1951, the Highway Research Board (HRB) Department of Soils, Geology, and Foundations established a *Committee on Landslide Investigations*, with Edwin B. Eckel as Chairman. It immediately sponsored publication of a bibliography on landslides [7] and then began to compile the information required to produce HRB Special Report 29, *Landslides and Engineering Practice*, which was published in 1958 [1]. By 1952, sufficient progress had been made to allow the publishing of two papers [8, 9] as HRB Bulletin 49. In 1959, Baker and Chieruzzi published a follow-up paper on regional aspects of landslide occurrence in HRB Bulletin 216 [10]. In 1963, the committee published five papers dealing with the stability of rock slopes in Highway Research Record (TRR) 17 [11, 12, 13, 14, 15].

Committee on Engineering Geology (A2L05) 1970-2003

Committee A2L05 was established in 1970 and very quickly was asked to undertake a revision of the existing 1958 landslide report [1]. In 1972, a special Task Force (A2T58), with six members and chaired by Robert L. Schuster, was established to undertake the revision. Special Report 176, *Landslides: Analysis and Control* [2] was published in 1978. This new report reviewed the considerable volume of new technical information developed since 1958. While the 1958 report reflected engineering practice in resolving landslide instabilities, the 1978 report reflected the evolving strategies for analysis and control of landslides. A single 30-page final chapter briefly reported on the analysis of rock slopes. This topic was further documented in 1980 by eight papers sponsored by A2L05 in TRR 783 [16].

During the early 1980's A2L05 collaborated with several committees to sponsor, or co-sponsor, sessions at the TRB Annual Meetings and selected papers were published in several TRR's describing the challenging engineering characteristics of clay and mudrocks [17, 18, 19, 20]. In the mid- 1980's, A2L05 increased its cross-disciplinary research interests. TRB began to publish TRR's consisting of papers on related topics, so A2L05 sponsored papers in a series of TRR's that addressed various topics such as: the treatment of problematic soils [21], geotechnology issues [22], and geophysics [23]. Members were actively involved in developing and testing computer-based simulation of rockfall events as a design tool; a paper describing the initial version of the Colorado Rockfall Simulation Program (CRSP) was published in 1990 [24].

Collaboration with external organizations greatly increased during this period. In 1995, A2L05 organized a full-day rockfall symposium at the 46th Annual HGS Meeting in Charleston, WV; this was the precursor to a series of annual mid-year meetings of A2L05 and A2L01 starting in 1998 (see Table 1). In October 1998, A2L05 organized a one-day symposium with 10 presentations on rockfall management and modeling at the AEG Annual Meeting in Seattle

In 1990, TRB asked A2L05 to determine whether to update and revise the 1978 landslide report [2]. A 10-member study committee, with several members including the Chair drawn from A2L05, was established; it completed Special Report 247, *Landslides: Investigation and Mitigation*, in 1996 [3]. This report contained 25 chapters written by 30 authors, and thus provided a much broader and extensive coverage than its predecessors. Four chapters with about 225 pages discussed rock slope issues, and seven chapters with 140 pages discussed special cases and materials, including: residual soils, colluvium and talus, loess, hydraulic tailings, and permafrost.

In 1991, A2L05 established two subcommittees to deal with expanding research issues: a Rockfall Management Subcommittee A2L05(1), and a Scour Committee A2L05(2). A third subcommittee Abandoned Underground Mines A2L05(3) existed 2000-2008.

Subcommittee A2L05(1) was charged with addressing the greatly expanded technical advances and research activity in evaluating the design, construction, and maintenance of rock slopes and in the assessment and mitigation of rockfall hazards. It selected a Sunday evening meeting time at the TRB Annual Meeting to ensure there were no conflicts with other committee meetings or sessions. It immediately attracted large audiences and it continues to remain an important and vibrant part of the parent Engineering Geology Committee; its meetings have become an important component of each TRB meeting for many attendees. In 1991 and 1992, A2L05(1) published rockfall related publication in TR News [25] and TRR 1343 [26].

Subcommittee A2L05(2) actively promoted research discussions on geological aspects of scour, especially its impact on bridge piers. The 2004 TRB Annual Meeting which resulted in the drafting of a Research Needs Statement that was funded as NCHRP Project 24-29 in 2006 (see next section). With its mandate achieved, the subcommittee was disbanded in 2008.

Committee on Engineering Geology (AFP10) 2004-2012

The 2004 restructuring of the TRB committees resulted in a new number (AFP10) and membership in a new section, but the activities of the committee continued without disruption. Committee activities covered a wide range of topics including: implementation of GIS technologies for geological investigations, subsidence and karst, new developments for subsurface characterization, reclamation of aggregate extraction sites, and digital image and visualization. These topics were addressed in one or more sponsored, or co-sponsored, lectern or poster sessions at each TRB Annual Meeting, and with Workshops in 2011 and 2012.

Half-day TRB-sponsored technical sessions at the HGS Meetings continued as annual mid-year meetings. Specific topics were selected based on recommendations from members of the AFP10 and AFP20 committees; these committees began to take turns in organizing the sessions (see Table 1).

Several AFP10 members served on the Review Panel for NCRP Project 24-29 *Scour at Bridge Foundations on Rock*, which was undertaken by former committee Chair Jeff Keaton and completed in 2012 [27, 28].

A new *Subcommittee on Geotechnical Asset Management AFP10(2)* was established in 2010. It organized the 2010 HGS technical session “Geotechnical Asset Management in a World of Dirt”. Because this subcommittee rapidly drew considerable interest, in 2015 TRB converted it to a subcommittee jointly sponsored by Sections AFP000 and AFS000, an unusual but very welcome move. Close collaboration with AFP10 continues.

AFP10 remained active in the landslide and rockfall management areas. AFP10 members were heavily involved in the organization of two North American landslide conferences; the first was held in Vail, Colorado, in 2007 [29] and the second in Banff, Alberta, in 2012 [30]. TRB co-sponsored both meetings which were highly successful. AFP10 collaborated with AFS20 to produce a TRB Circular discussing the use of inclinometers [31].

AFP10 and subcommittee AFP10(1) were heavily involved in developing a new TRB Report *Rockfall: Evaluation and Control*, published in 2012 [4]. It was developed by a special task force chaired by A.K. Turner and staffed by AFP10(1) members. The task force was created in 2005 and developed several reports during the period, including two TRB-related publications – a TRB Circular [32] and a TR News Research Pays Off discussion[33]. *Rockfall: Evaluation and Control*

[4] serves as a companion to Special Report 247, *Landslides: Investigation and Mitigation* [3] with a greatly expanded discussion of rock slope stability analysis and rockfall mitigation, topics that evolved rapidly after 2000. Widely adopted, *Rockfall: Evaluation and Control* was awarded second place in the Washington Book Publishers 2013 Book Design and Effectiveness Competition in the Small- to Medium-Sized Nonprofit Publishers Technical Text category.

TABLE 1: Summary of TRB-Sponsored Sessions at HGS Annual Meetings

Year	Month	No.	HGS Location	TRB Technical Session	TRB Sponsor
1995	May	46 th	Charleston, WV	Rockfall Symposium (full day with field trip)	A2L05 & A2L05(1)
1998	Sept	49 th	Prescott, AZ	Rockfall Mitigation Measures	A2L05 & A2L05(1)
1999	May	50 th	Roanoke, VA	Karst Terrain	
2000	Sept	51 st	Seattle, WA	Large Landslide Mitigation	A2L05 & A2L05(1)
2001	May	52 nd	Cumberland, MD	<i>Topic unavailable</i>	
2002	August	53 rd	San Luis Obispo, CA	Design and Construction in Melange	A2L05 & A2L01
2003	Sept	54 th	Burlington, VT	Condition Assessment of Rock Reinforcement	A2L05 & A2L05(1)
2004	Sept	55 th	Kansas City, MO	Geotechnical Methods Revisited	AFP20
2005	May	56 th	Wilmington, NC	Aggregates for Use in Highway Construction	AFP10 & AFP20
2006	Sept	57 th	Breckinridge, CO	Applications of Geophysics to Geotechnical Projects	
2007	Oct	58 th	Pocono Manor, PA	Differential Weathering of Rock Slopes	AFP10
2008	May	59 th	Santa Fe, NM	Problem Soils and Surficial Deposits	AFP20
2009	Sept	60 th	Buffalo, NY	Long-term Performance of Geotechnical Infrastructure	AFP10 & AFP20
2010	August	61 st	Oklahoma City, OK	Asset Management in a World of Dirt	AFP10 & AFP20
2011	July	62 nd	Lexington, KY	Geophysical Explorations, Non-Destructive Evaluation and Monitoring Techniques for Landslides, Rockfall and other Geohazards	AFP10 & AFP10(1)
2012	May	63 rd	Redding, CA	Design and Construction of Rockfall Mitigation Systems	AFP10 & AFP10(1)
2013	Sept	64 th	North Conway, NH	Site Characterization and Monitoring for Highway Engineering Problems	AFP20 with AFP10 & AFP30
2014	July	65 th	Laramie, WY	Geosynthetics in Roadway Design	AFS70
2015	Sept	66 th	Sturbridge, MA	Geotechnical Risk: Assessment and Performance Management	AFP10 & AFP20
2016	July	67 th	Colorado Springs, CO	Geological Modeling: Methods and Methodologies	AFP10 & AFP20
2017	May	68 th	Marietta, GA	State-of-the-Art Practices in Subsurface Investigations	AFP10 & AFP20
2018	Sept	69 th	Portland, ME	Geotechnical Asset Management: Implementation of Programs and Advances in Technology	AFP00(1)

2019		70 th	Portland, OR	Looking Ahead at Informed Decision-Making for Engineering Geologists	AFP10 & AFP20
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Recent AFP10 Activities (2013-2018)

AFP10 continued to actively pursue a range of research topics. Sponsored and co-sponsored sessions at TRB Annual Meetings addressed the use of geological models and other innovative approaches to subsurface investigations, geological hazard investigations, sustainability issues in geological and geoenvironmental engineering, and innovations in geotechnical data collection and visualization. AFP10 contributed to a NCHRP Synthesis published in 2015 which provided additional information on visualization of geotechnical data [34]. A TRB Webinar was aired in 2016 that was based on this NCHRP Synthesis [35].

Collaboration with external professional organizations and outreach continued. Mid-year TRB-sponsored technical sessions at HGS meetings included several of the topics mentioned in the previous paragraph, but in 2014 a session on Geosynthetics was offered with the assistance of AFS70. In June 2017, TRB co-sponsored the 3rd North American Symposium on Landslides, which was held in Roanoke, Virginia with the theme: *Landslides: Putting Experience, Knowledge and Emerging Technologies into Practice*. Several AFP10 members were involved in organizing this conference or attended and made presentations.

Geotechnical Asset Management became an ever-larger and important activity. Attendance at Subcommittee AFP10(2) meetings continued to grow, and each TRB Annual Meeting had a sponsored session with a Geotechnical Asset Management topic.

Rockfall-related topics continued following the 2012 publication of *Rockfall: Evaluation and Control* [4]. A TR News article was published in 2013 [36], and two different TRB Webinars, based on different aspects of the rockfall report, were aired in April 2014 [37, 38]. One AFP10 Research Needs Statement concerning the certification and management of flexible rockfall protection systems was successfully funded as NCHRP Project 24-35, that resulted in the publication of NCHRP Report 823 in 2016 [39].

AFP10 Future Plans and Goals (2019-onward)

AFP10 continued to be actively engaged during the 2019 TRB Annual Meeting. The Committee sponsored two events, a workshop titled Extreme Weather Impacts on Geohazards: Lessons and Methods to Incorporate Resilience to Geotechnical Assets; and a poster session titled Geotechnical Asset Management: Risk, Rockfall, and Sinkholes. The workshop covered the hot topics of climate change and resilience of transportation in response to geohazard events triggered by extreme weather. There were 11 presentations selected for the poster session several of which were given by university students.

The 2018 AFP10 Triennial Strategic Plan (TSP) provides some general guidance as to the anticipated future activities of the committee; it also outlines some challenges. Several topics have continued or expanded relevance. Geotechnical Asset Management (GAM) is one such topic. While the Section-level *Geotechnical Asset Management Subcommittee* will take lead in setting the agenda, AFP10 is anxious to participate. It can provide some technical expertise in evaluating geological conditions that may influence the performance of geotechnical assets. Of equal importance, GAM procedures will undoubtedly require changes to current procedures for engineering geological data collection and management; these will in turn influence geotechnical design.

GAM is but one aspect of the increased interest in the economic and societal value of engineering geological observations, data collection, and data management. Perceived trends in technology, coupled with economic and legal liability constraints, provide new opportunities and challenges to engineering geology. The application of engineering geology is becoming more critical to the efficient design, construction, and management of transportation systems as the entire process is becoming more dependent on data-driven decision-making.

Technological advances are rapidly changing the technical and economic characteristics of geological information management. In the past five years, software solutions have appeared that make it economically feasible to create digital geological models defining the subsurface characteristics of construction sites. These have been applied to several European projects but have yet to be used extensively in the USA. New digital visualization technologies, including Augmented Reality applications, have begun to be used for both collaboration among members of a project design team as well as for public outreach and participation.

AFP10 has already seen demonstrations of how “game engines” – specialized computer chips used for computer games – can be readily applied to simulate complex rockfall cases. Because the game engines accurately represent complex physical principles, they offer a very economical method of developing geological simulations of many geological or geotechnical processes. However, such developments will require collaborations between geologists, geotechnical engineers, and IT developers.

Digital technologies are increasingly influencing other engineering geology activities. Mobile data collection devices are being used to collect field observations. The reduced cost and increased effectiveness of monitoring devices that can be queried remotely and can send warning alerts to central offices means that these will be used more often. As the collection and use of aerial data become mainstream and the technologies to visualize geologic data and develop surface and subsurface models improves, the use of geologic models will increasingly support the design of transportation infrastructure. Promoting proper use of these models will be an important focus for AFP10; it will stress the subjective nature of geologic information and the importance of empirical observation and adherence to geologic engineering principles.

AFP10 has several members who are actively involved in state-of-the art developments on several of these topics. Recent committee presentations have shown that many of these technologies will soon become state-of-practice. While some more formal TRB presentations have been included in recent TRB sessions, more efforts will be required in the next few years.

AFP10 plans to develop research and problem statements that reflect cross-cutting issues that include: 1) the effect of extreme weather events and long-term weather pattern changes on earth material and geologic hazards, and 2) the establishment of appropriate methods for the collection, visualization, management, quality assurance, and control of data used to measure the performance of earth materials and geologic hazards. Together, these cross-cutting issues are fundamental to achieving DOT goals of safety, mobility, and assessment of system reliability and condition. More specifically, AFP10 is developing plans to:

- 1) Promote the proper use of geologic data in planning, design, construction and maintenance of transportation systems including the development of investment strategies from a geotechnical asset management perspective,
- 2) Improve the quality of applied research for engineering geology as it applies to transportation systems,

- 3) Collaborate with TRB committees and other engineering geology professional organizations to improve the state of practice of investigating and assessing engineering geology as it applies to transportation systems by performing innovative research,
- 4) Provide opportunities for oversight, timely critiques and reviews of research results; and the dissemination of valuable research contributions to the science of engineering geology, and
- 5) Continue to respond to requests from TRB for engineering geology information.

The 2020 committee membership rotation will provide for the potential appointment of a few new members with expertise that can be applied to these tasks. An overhaul of the membership is not proposed, only the expansion of the knowledge base and expertise within AFP10. The emphasis on rockfall and the revision of the landslide book will continue as the tasks for the two existing subcommittees. Discussions are planned to determine if it is feasible to expand the mandate of the rockfall management subcommittee to include a broader range of topics related to unstable natural slopes, with possibly a new subcommittee scope and a new name. The subcommittee is already considering some topics that are relevant to other slope types.

Consideration will be given to the establishment of one, or more, additional subcommittees to address the issues of geological model applications and/or geological data management concerns. The establishment of additional subcommittees would potentially provide additional associate members to help with the increased effort of supporting multiple goals simultaneously. If this path is followed, the AFP10 committee members would undertake the role of coordination among the subcommittees. Each subcommittee would have its own (shorter) meeting time to allow for discussion and informal presentations. Each subcommittee could offer ideas and action steps to the AFP10 committee, as well as assist with follow-through on action items. Subcommittees would provide needed attention to these topic areas and allow for cross-communication, prioritization and coordination under the guidance of AFP10 leadership.



Mud Creek Landslide, Highway 1 South of Big Sur, California

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