Penrose CONFERENCES
THE GEOLOGICAL SOCIETY OF AMERICA
REPORT

Climatic Controls on Continental Erosion and Sediment Transport (CLAST2019)

4–10 August 2019 | Juneau, Alaska, USA

CONVENERS

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INTRODUCTION AND CONFERENCE DETAILS

Although tectonic forces are known to be a strong primary control on the generation of sediment, this conference assessed the dynamic role of global and regional climate in controlling the production, transport, and deposition of sediments over millennial to million-year time scales. However, study of climate and earth-surface process relationships is fundamentally problematic because many of these processes act both independently of and as a consequence of tectonic forcing. This conference sought to discuss how climatic forcing is translated to the sedimentary record and under what conditions the respective erosional signals can be observed and interpreted unambiguously in terms of paleoenvironmental and paleoclimatic change. This transdisciplinary meeting brought together researchers across a number of sub-fields to showcase the current state of research, demonstrate contemporary evidence and methods from studies worldwide, and summarize the research concerns remaining in our communities.

Hosted in Juneau, Alaska, USA, from 4–10 August 2019, CLAST2019 brought together 49 scientists from Australia, Brazil, Canada, France, Germany, Hong Kong, Israel, Italy, Switzerland, the U.K., and the U.S. The conference kicked off with an ice-breaker, was punctuated by a mid-week field trip and sunset dinner on Eagle Beach delta, and ended in Tracy Arm Fjord in the post-meeting field trip. Women scientists accounted for 46% of participants, and 23 of the participants were early career researchers (student and untenured researchers). Early career researchers presented one third of invited talks. Formalized one-on-one and informal peer mentoring was achieved throughout the week among researchers and across the wide range of disciplines.

Presentations were grouped into seven broad climate-erosion themes: (1) from source to sink: tracing erosional signals; (2) beyond the mainstream: continental deposition and erosion outside fluvial systems; (3) cycles, thresholds, and feedbacks: the evolving atmosphere and biosphere; (4) from ice to the ocean; (5) closing the gap: emergent tools and techniques for integrating earth-surface processes and solid Earth datasets across time scales; (6) moving forward: innovations in data sharing, visualization, and modelling to understand landscapes and climate; and (7) history matters: reconciling tectonic, climate, and erosion histories.

PRESENTATIONS AND DISCUSSION

The major aims of the talks and focused group discussions were to (1) identify new and persistent knowledge gaps within our communities; (2) define major challenges in addressing these gaps; and (3) initiate conversations on the resources needed both within, between, and outside of our communities to effectively address these over the next five to ten years. Over the course of the week, participants identified three key areas:

Weather Erodes, Not Climate

Understanding the relative importance of event-scale and extreme events in controlling the sedimentary record has come to the forefront of several communities. What is the relative importance of extreme events over steady-state erosion processes? Are extreme events (mass-wasting, cyclones, wildfires, earthquakes, [flash-]floods) controlling the sedimentary record, or are these events the "noise"? At what scales are events detectable and at what scales do they matter?

To understand the immediate and lasting effects of seasonality and variability, efforts need to be made in not only obtaining measurements of *totals* but also in constraining *rates* and *durations*. This includes identifying records for environmental boundary conditions in the rock record (elevation, temperature, precipitation, wind speed, aridity, and seasonality) and improving our ability to measure them using novel (bio)geochemical markers, such as clumped isotopes.

Scale Matters, So Mind the Gap

The issue of comparing observations at varying temporal and spatial scales was identified as a key challenge. We have disparate proxies relevant at different spatiotemporal scales and are especially data limited at time scales that might matter. Improvement in geochronological techniques has in part addressed this data gap, but continued effort is needed. Future approaches looking to quantify transience or disequilibrium will need to allow for a holistic interpretation of disparate proxies and include development of proxies that are truly compatible with the scale of observation.

CLAST2019 attendees at the Mendenhall Glacier as part of the mid-week field trip. Back row (left to right): Sergio Andò, Niels Hovius, Karl Lang, Kelly Thomson, Mathieu Cartigny, Justin Lawrence, Daniella Rempe, Ian Delaney, Eva Enkelmann, Jane Willenbring, Ken Ferrier; Middle-back row (left to right): Pedro Val, Alexis Licht, Jan Blöthe, Glenn Sharman, Anna Clinger, Al Neely, Christian France-Lanord, Kristen Cook, Jessica Raff, Mitch D'Arcy, Hon-chim Chiu; Front-back row (left to right): Yani Najman, Xiaoni Hu, Claire Mastellar, Julia Carr, Kathleen Marsaglia, Nick Brilli, Anthony Maue, Eran Hood, Cathy Connor, Marguerite Toscano, Michal Ben-Israel, Duna Roda-Boluda, Steffi Tofelde; Front row (left to right): Tara Jonell, Donovan Dennis, Brian Yanites, Kalli Dubois, Yuting Li, Peter Clift, Adam Forte, Luca Malatesta, Veronica Prush, Sonia Nagorski, Nicole Gasparini, Udita Murkherjee. Photo credit: Tongass National Forest park ranger at Mendenhall Glacier.

Following on the key area above, the community highlighted the necessity for the development of *possible, plausible,* and *probable* models that can be appropriately upscaled from numerical and analog frameworks to test at the field scale. This includes developing coupled chemical and physical models that can be better applied when translating chemical fluxes (i.e., nutrients, carbon) along with records of physical erosion.

Landscape Connectivity (Buffers, Barriers, and Blankets)

The impact of landscape connectivity on source-to-sink dynamics has been an incredibly popular topic across geoscience fields for the past two decades and so consequently pervaded many discussions at the conference. Significant improvements have been made in understanding the role of signal shredding as a result of poorly connected landscapes, in how this process often biases sedimentary records, and over which spatiotemporal scales this process may inhibit accurate interpretation. Yet there are still issues in translating nonlinear behavior from erosional records, especially when non-unique responses are observed in both source and sink signals. Instead of viewing sedimentary systems as separate hillslope or fluvial systems, a nested perspective has proven useful for understanding landscape response and in identifying directionality of critical threshold behaviors. Recent work with community models has yielded interesting results and may continue to offer time- and energy-efficient ways in which to test hypotheses underpinned by empirical evidence from the field. Lastly, we recognized that necessary improvements are needed to identity the impact landscape legacy effects and how best to quantify "landscape memory" processes and rates.

ACKNOWLEDGMENTS

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Abstracts of presentations are available at **www.geosociety.org/penrose** (click the "archive" tab).

FIELD TRIPS AND GUIDES

An informal field-trip guide for the two field trips was compiled by the meeting conveners using text and figures compiled by UAS field trip leaders: Cathy Connor, Eran Hood, and Sonia Nagorski. This field trip guide is freely available at **www.geosociety.org/penrose** (click the "archive" tab).

Participants

Sergio Andò, Michal Ben-Israel, Jan Blöthe, Nicola "Nick" Brilli, Julia Carr, Matthieu Cartigny, Peter Clift, Anna Clinger, Cathy Connor, Kristen Cook, Mitch D'Arcy, Ian Delaney, Donovan Dennis, Roman DiBiase, Kalli Dubois, Eva Enkelmann, Ken Ferrier, Adam Forte, Christian France-Lanord, Nicole Gasparini, Eran Hood, Niels Hovius, Xiaoni Hu, Tara Jonell, Karl Lang, Justin Lawrence, Yuting Li, Alexis Licht, Luca Malatesta, Kathleen Marsaglia, Claire Mastellar, Anthony Maue, Udita Mukherjee, Sonia Nagorski, Yani Najman, Alexander Neely, Veronica Prush, Jessica Raff, Daniella Rempe, Duna Roda-Boluda, Glenn Sharman, Kelly Thomson, Stephanie Tofelde, Marguerite Toscano, Pedro Val, Jane Willenbring, Brian Yanites, Xiaoping Yuan, Peng Zhou.