frontiers | Frontiers in Environmental Archaeology

TYPE Perspective
PUBLISHED 07 July 2025
DOI 10.3389/fearc.2025.1568765

OPEN ACCESS

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RECEIVED 30 January 2025
ACCEPTED 26 May 2025
PUBLISHED 07 July 2025

CITATION
Favier Dubois CM (2025) Advances, debts, and prospects of geoarchaeology in Latin America. *Front. Environ. Archaeol.* 4:1568765. doi: 10.3389/fearc.2025.1568765

Advances, debts, and prospects of geoarchaeology in Latin America

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Geoarchaeology began to develop in Latin America during the 1990s, driven by geoscientists with a keen interest in this interdisciplinary field. In the 21st century, geoarchaeology has continued to grow significantly in the region due to its increasing importance in enhancing archaeological interpretations. This discipline provides a contextual framework for understanding site stratigraphy and formation processes, addressing critical questions such as whether a site is *in situ* or has been reworked, the significance of material associations, and the temporal resolution of assemblages, among other topics. These contributions make geoarchaeological studies essential for any archaeological research. Consequently, this discipline should be an integral part of the undergraduate curriculum for professional archaeologists. However, due to traditional approaches in the field, geoarchaeological content—if included at all—remains scarce in Latin American universities, even in programs offering long-term degrees in Anthropology or Archaeology. This represents a significant gap that must be addressed in the near future. Since 2012, GEGAL (Grupo de Estudios Geoarqueológicos de América Latina) has worked to promote and advance geoarchaeology, striving to shape the discipline with a distinct Latin American perspective. Despite ongoing challenges, geoarchaeological research in Latin America today demonstrates considerable diversity, high quality, and growing international recognition.

KEYWORDS

archaeology and geosciences, site formation processes, transdisciplinary studies, Latin American academic tradition, curricular gap

Developing geoarchaeology in Latin America

This paper offers a reflective overview of the development and current state of geoarchaeology in Latin America, based on both academic literature and the author's involvement in regional initiatives. Rather than presenting a systematic review, it seeks to highlight key milestones, research trends, and institutional efforts—particularly those promoted by the GEGAL—that have contributed to the growth of the field. The aim is to provide context for the ongoing consolidation of geoarchaeology within Latin American archaeology, emphasizing its educational, methodological, and collaborative dimensions.

Since the 1970s and 1980s, numerous studies have demonstrated the significant relevance of geoarchaeology for archaeological research and interpretation. During the 1990s, this discipline began to take shape in Latin America, driven by the pioneering efforts of geoscientists who recognized its potential. Among these pioneers were Zárate and Flegenheimer (1991) and Tchilinguirian and Barandica (1995) in Argentina, Van der Hammen (1991) in Colombia, and Araujo (1995) and de Morais (1999) in Brazil. Their contributions inspired a new generation of archaeologists to adopt and

integrate this discipline, enabling a deeper understanding of the natural and cultural dimensions of the archaeological record.

In the 21st century, geoarchaeology has continued to advance significantly in Latin America. The number of practitioners and publications within this field has grown, leading to the organization of dedicated geoarchaeology workshops and symposia. These events first emerged within archaeological contexts (starting in 2001) and later expanded into geological venues (beginning in 2005). In 2012, the establishment of GEGAL (Grupo de Estudios Geoarqueológicos de América Latina, or Group of Geoarchaeological Studies of Latin America) marked a key moment in the consolidation of this field, accelerating regional and international advancements in geoarchaeological research.

But what makes the development of geoarchaeology so critical? Geoarchaeology allows for a comprehensive understanding of site stratigraphy and formation processes—crucial aspects that are often relegated in the disciplinary training of Latin American archaeologists but form the foundation of many archaeological interpretations. Essentially, geoarchaeology can be defined as the application of earth science methods and concepts to archaeological research (Butzer, 1982). However, within the Latin American academic tradition, which draws heavily from classical European archaeology, the geo-environmental dimensions of the archaeological record have historically been considered peripheral or belonging to other fields of knowledge. As a result, geoarchaeological content is largely absent from most Anthropology or Archaeology programs in Latin American universities, despite these programs often spanning several years of study.

Archaeologists need a foundational understanding of geoarchaeology, just as they require expertise in lithic, ceramic, or bone analysis. This gap in academic training must be addressed. While some universities include geoscience courses in their Archaeology or Anthropology curricula, these courses are often designed with objectives, scales, and questions unrelated to archaeology, making them insufficient substitutes for true geoarchaeology courses. The inclusion of geoarchaeological content in undergraduate studies will result in a clear improvement in the academic training of archaeology professionals. Furthermore, the increase in the number of theses or final projects with this focus will produce more specialists, which will enable a greater number of archaeological research teams to have this support. The future of geoarchaeology in Latin America depends on its effective integration into undergraduate programs. Without this step, the discipline will remain a specialized field pursued by only a handful of archaeologists at the postgraduate level.

How does GEGAL collaborate?

GEGAL aims to develop a distinct Latin American profile for geoarchaeology, tailored to the interests, needs, and resources of the countries in the region. The group currently has members across 14 Latin American nations. GEGAL organizes annual workshops, rotating among member countries, which are attended by professionals and students alike. Since its inception, 10 workshops have been held: I Olavarria, Argentina (2013); II Los Vilos, Chile (2014); III Quito, Ecuador (2015); IV La Paloma, Uruguay (2016); V Manizales, Colombia (2017); VI Ubajara, Brazil (2018); VII Lima, Peru (2019); VIII La Plata, Argentina (2020); IX México DF, Mexico (2022); X São Paulo, Brazil (2023). The latter was held in conjunction with the 10th DIG (Developing International Geoarchaeology), bringing together two international geoarchaeology groups for a joint meeting. These workshops include oral presentations and field trips, promoting the exchange of methodologies, experiences, and ideas (Figure 1).

GEGAL has also contributed to the dissemination of geoarchaeological knowledge by sponsoring the publication of three books on Latin American geoarchaeology: two in Brazil (Rubin and Silva, 2013; Rubin et al., 2015) and one in Ecuador (Ugalde, 2017), featuring contributions from five countries in Spanish and Portuguese. Additionally, a selection of papers, many originating from workshop presentations, has been published in five special journal volumes, in Spanish, Portuguese, and English. One of them is a special issue of *Geoarchaeology* (vol. 32–6, 2017). These books and most special volumes are available for download on the GEGAL website (http://www.gegal.net). Other important compilations of Latin American geoarchaeological research, not related with GEGAL, include two special journal volumes (Salemme et al., 2016; Sitzia et al., 2022) and a book on regional geoarchaeology (Sampietro Vattuone and Peña Monné, 2016).

These publications highlight key research areas in the field, including landscape reconstruction and site formation processes across diverse depositional and cultural contexts, such as caves and rockshelters, open-air sites (e.g., fluvial, eolian, coastal, and volcanic settings), shell mounds and shell middens, anthropogenic and agricultural soils (including *Terra preta* and other distinct types), earthen mounds (locally referred to as *cerritos*, *aterros* and *tolas*), and mudbrick structures. Ongoing work in this area is further complemented by the application of geoarchaeological methods to historical-period sites, reflecting the diverse interests and methodologies emerging from the region's growing research efforts.

In parallel to these publications, GEGAL has expanded its contributions to training and professional development. Since 2018, the group has offered online courses designed to equip students and professionals with essential geoarchaeological knowledge in topics such as sediments, stratigraphy, geomorphology, soils, and micromorphology, all applied to archaeological research. To date, over 600 students from 16 Spanish- and Portuguese-speaking countries have participated in these courses, furthering the regional dissemination of geoarchaeological expertise.

Looking ahead, GEGAL has established the first Geoarchaeology Field School, which started in 2024 in the city of Miramar (Buenos Aires, Argentina). This initiative provides participants with hands-on field training in diverse geomorphological and stratigraphic contexts, further strengthening geoarchaeological education and practice in the region.

Improving the background of Latin American practitioners

Many geoarchaeological studies in Latin America have been conducted collaboratively by archaeologists and geoscientists. However, as previously noted, archaeologists often have limited or no knowledge of geosciences, while geoscientists tend to lack an understanding of archaeology. Similar to other regions,

FIGURE 1
Visit to the Rumipamba site in Quito, Ecuador, during the IV GEGAL Workshop. These field excursions provide a valuable opportunity for exchanging perspectives and practices within the framework of the workshops.

communication challenges between these two groups arise from differences in objectives, interests, scales, and methodologies. These issues have traditionally hindered interdisciplinary collaboration and continue to pose difficulties today (Karkanas and Goldberg, 2019).

How can these challenges be addressed? First, by recognizing and acknowledging these limitations. Second, by developing specialized training courses in geoarchaeology—not in geosciences or archaeology, but specifically in geoarchaeology. These courses should focus on understanding sediments, soils, stratigraphy, micromorphology, and geomorphology as they relate to archaeological sites, with questions and interpretations always grounded in archaeological contexts. Such courses should be designed for both archaeologists and geoscientists, at both undergraduate and postgraduate levels. Neither archaeology nor geosciences alone can provide the comprehensive tools required to address the natural-cultural dimensions of the archaeological record. This is the central challenge of geoarchaeology and its practitioners.

In Latin America, efforts are being made to meet this goal, striving to move from interdisciplinarity to transdisciplinarity. However, there is still significant progress to be made. Transdisciplinarity must be a two-way process, requiring comprehensive training for both archaeologists and geoscientists. That said, it is archaeology that must take the lead in investing in robust intra-disciplinary teaching, ensuring that geoarchaeology becomes an integral part of the academic curriculum for all archaeology students. This knowledge is essential for professional archaeological practice.

The transdisciplinary challenge of geoarchaeology in Latin America

Geoarchaeology represents a transdisciplinary challenge that is progressing slowly in Latin America. Although many years have passed since the discipline's initial development, it has yet to be fully integrated into archaeological research or academic programs across the region. To address this, it is essential to increase the availability of specialized courses at both undergraduate and postgraduate levels, alongside the implementation of field and laboratory practices. These efforts should deepen the study of the natural-cultural dimensions that define archaeological sites.

While geoarchaeology is primarily an archaeological discipline, it emerged through the integration of methodologies derived from the geosciences. Consequently, geoarchaeological research has traditionally emphasized the natural processes involved in site formation. Nonetheless, there is a critical need to develop more integrative approaches that explicitly incorporate cultural processes, which can sometimes play a clearly predominant role. These processes are often recorded in the stratigraphy, and we must be able to recognize them—an effort that requires the development of specific methodological tools. Such an approach is well exemplified in some studies on shell mounds (e.g., Villagrán et al., 2009, which introduced the concept of archaeofacies), earthen mounds (e.g., Castiñeira et al., 2013), and mudbrick structures (e.g., Mauricio et al., 2021).

Nevertheless, significant gaps remain in the basic understanding of archaeological site formation processes across many regions in Latin America. To address this, it is critical to train local experts by updating academic curricula. This will enable archaeologists to determine whether to apply general or more specialized geoarchaeological methodologies, optimizing the use of available resources by balancing detail and equipment requirements with practical constraints.

Despite the challenges, Latin American geoarchaeological research currently showcases remarkable diversity, quality, and international visibility, as highlighted during the last 10th DIG-GEGAL meeting. Over the years, numerous professionals have collaborated to incorporate innovative methodologies and analytical techniques to tackle issues at various scales across the region's diverse geographies. These efforts take into account the unique interests, priorities, and economic realities of Latin America.

The consolidation of geoarchaeology within the broader discipline of archaeology will not only enhance professional practice but also contribute to a deeper understanding of the archaeological record and its significance.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Written informed consent was not obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article because it is a photograph of a workshop session. The image was edited to remove any identifiable faces.

Author contributions

CF: Writing – original draft, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research and/or publication of this article.

Acknowledgments

I would like to express my sincere thanks to Ximena Villagrán and the organizing committee of the 10th DIG-GEGAL meeting held in São Paulo (2023) for their generous invitation and inspiring discussions. I am also grateful to the GEGAL, within whose framework—through numerous meetings and exchanges with colleagues and students—my understanding of geoarchaeology and its vast potential within archaeological research has been significantly enriched. Finally, I thank the reviewer for their insightful comments and constructive suggestions, which helped improve the clarity and depth of this manuscript.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

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