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INTERNATIONAL PIPELINE GEOTECHNICAL CONFERENCE

Organizan:
COMITÉ TÉCNICO IPG
ACIEM Asociación Colombiana de Ingenieros

PROYECTO ARPEL LATINOAMERICA: ELABORACIÓN DE GUIAS TÉCNICAS DE MONITOREO Y OBRAS DE CONTROL EN GEOAMENAZAS EN DUCTOS

GRUPO EPGEO

07 de Noviembre de 2025

Contenido general

Documento: YPF-Privado

01 EPGEO: ¿Quienes somos?

Somos el Equipo de Profesionales de Geotecnia - EPGEO- de ARPEL.

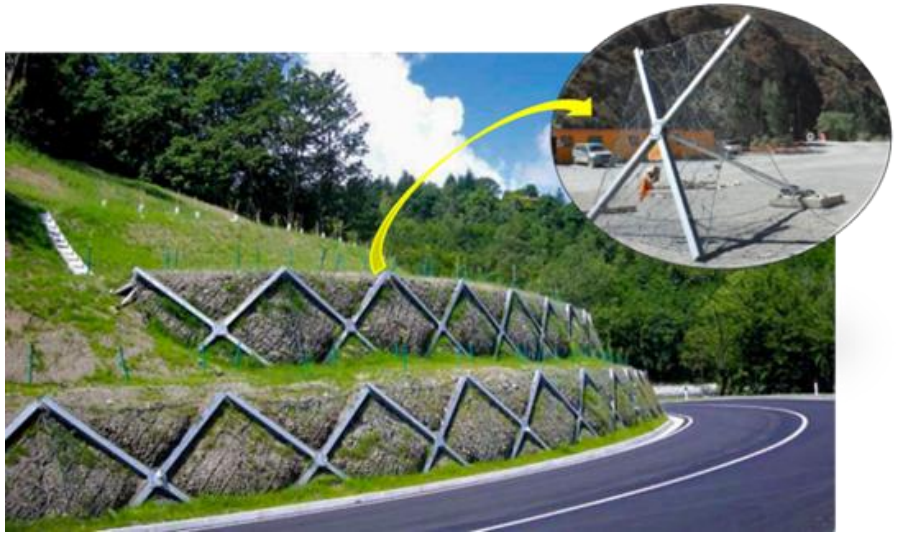
Profesionales de empresas socias o invitadas de ARPEL, cuyo propósito es generar 3 guías técnicas para registrar la experiencia de región andina respecto a la gestión de geoamenazas en ductos.

Un equipo que viene trabajando desde el al año 2014. Ya hemos finalizado 2 guías técnicas y estamos en la elaboración de la tercera.

RECOPE pluspetrol cenit YPF OCENSA

OCPECUADOR TGN YPFB tgp BR TRANSPETRO

02 Objetivos



- ✓ Elaborar 3 guías técnicas relacionadas con la gestión de geoamenazas para sistemas de ductos de transporte de petróleo y gas de la región andina:

  i. Monitoreo de las geoamenazas,
  ii. Obras de control de erosión y
  iii. Riesgo por geoamenazas.

- ✓ Proponer una metodología de trabajo para gestionar el conocimiento y aportar la gestión de la integridad de los activos de las empresas a nivel regional.

- ✓ Fortalecer la comunicación entre empresas operadoras de ductos de petróleo y gas en la región.

03 Metodología de trabajo

Talleres presenciales

Videoconferencias

Compartir las experiencias entre los diferentes integrantes del EPGEO.

Estrategia de discusión técnica mediante reuniones virtuales y talleres presenciales.

Mas de 150 encuentros virtuales.

Realización de talleres presenciales en Colombia y Argentina.

Uso de herramientas informáticas para asegurar el avance en la construcción de los documentos.

Bajo la moderación de ARPEL.

03 Metodología de trabajo

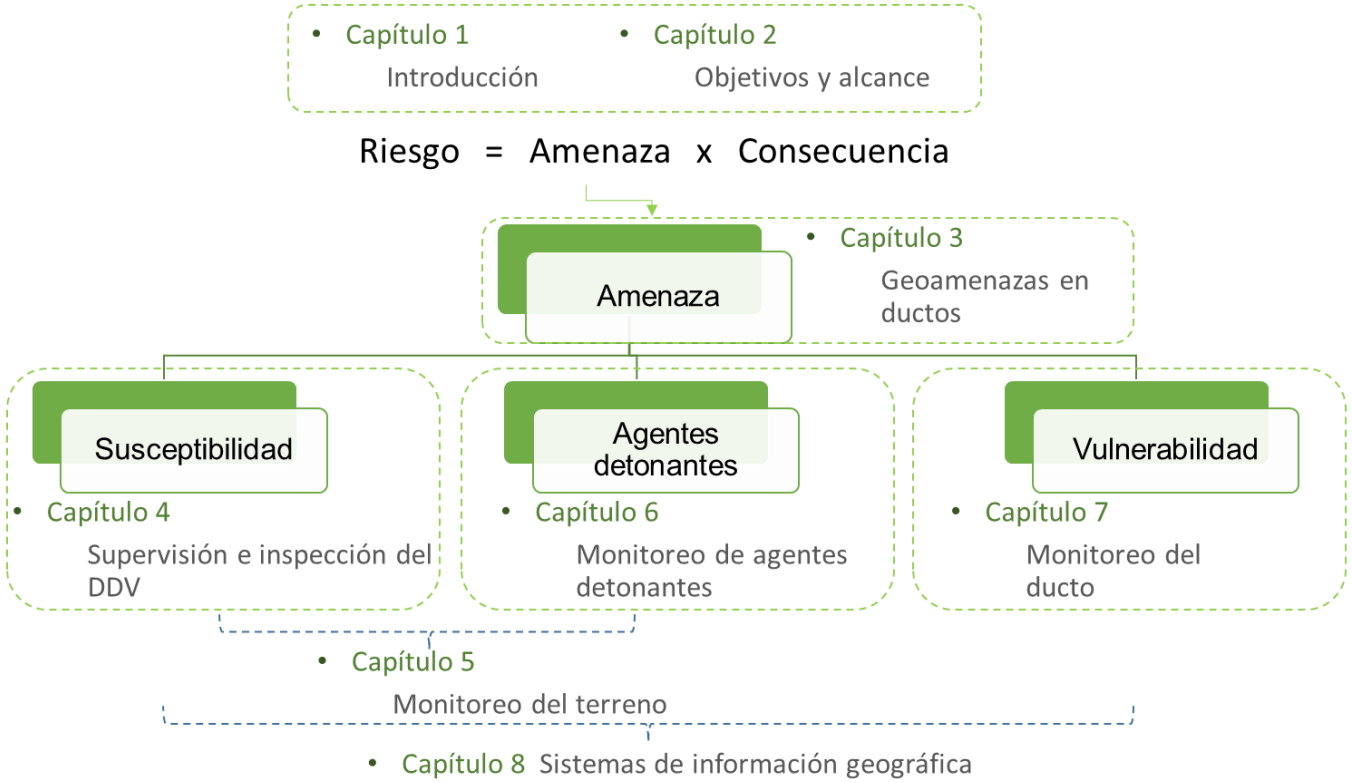
Línea de tiempo.
Flujo de trabajo equipo EPGEO -ARPEL

04 Resultados

•**Guía 1 (2016):** Monitoreo e inspección de ductos frente a geoamenazas.
•Incluye tipologías, mecanismos de supervisión, SIG, y casos prácticos.
•Al final de la guía 1 (327 páginas) se consolidaron experiencias concretas de aplicación de las técnicas, para dar mayor claridad y aplicabilidad de los conceptos.

- Deslizamientos y otros mecanismos (fluencia, flujos, etc.)
- Hidrotécnicas: cruces de ríos (socavaciones, crecidas, avulsiones, invasiones)
- Erosión en el ROW: longitudinal, cárcavas, olas y viento, asentamiento
- Terremotos: fallas y licuefacción
- Meteorológicos: tormentas eléctricas, relámpagos Inspección del resto del mundo
- Monitoreo y levantamiento del terreno
- Factores desencadenantes
- Monitoreo de tuberías SIG aplicado
- Soluciones aplicadas para mejorar la integridad de las tuberías frente a los peligros geológicos

04 Resultados



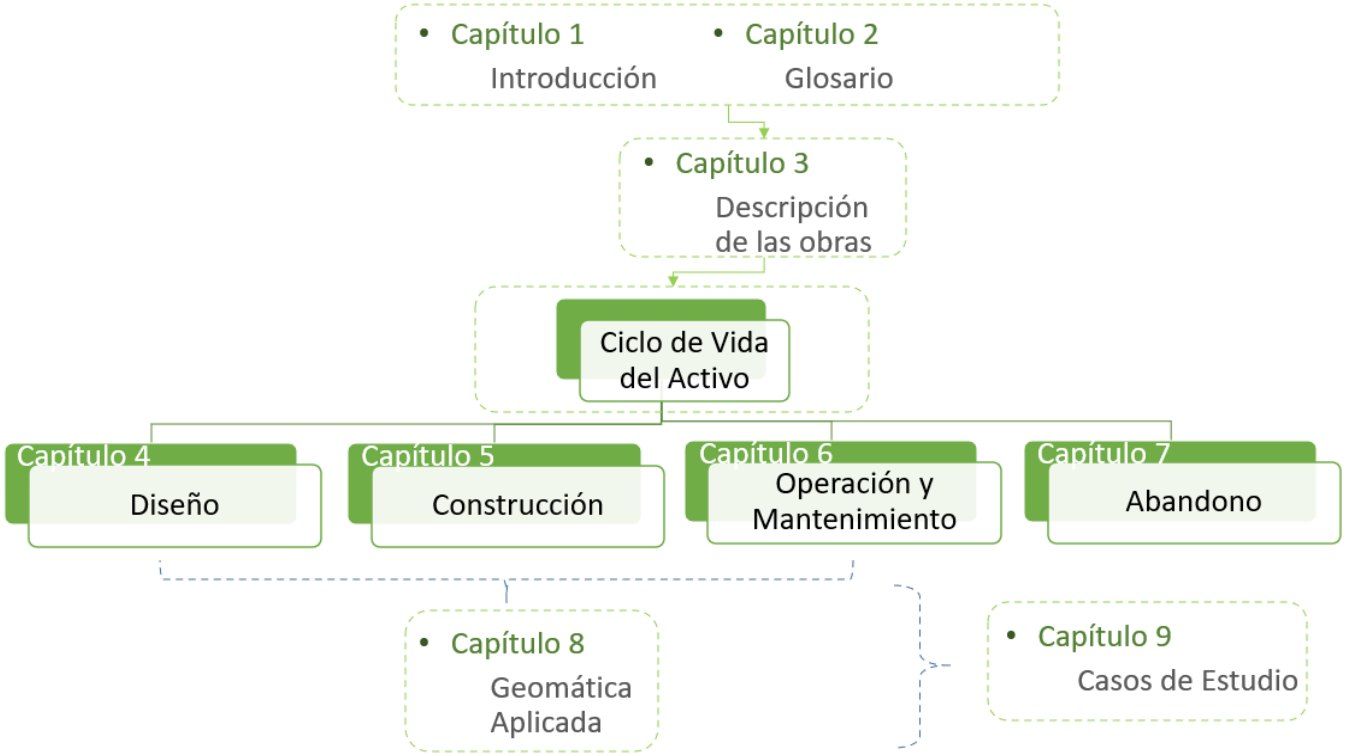
04 Resultados

En agosto de 2023 se publicó la **Guía 2** (202 páginas), relacionada a Obras de Mitigación Geotecnia en Ductos [11], que fue elaborada principalmente a través del uso de herramientas tecnológicas mediante reuniones virtuales

Listado de obras

- Drenaje de superficie
- Drenaje subsuperficial
- Cruces de ríos
- Estabilización de deslizamientos
- Líneas costa afuera
- Obras especiales (túneles, HDD, puentes, etc.)
- Diseño de tuberías
- Construcción
- Operación y mantenimiento
- Abandono técnico de oleoductos
- Geomática aplicada Casos de campo

04 Resultados



05 Próximos pasos

- La Guía 3 abordará el **análisis de riesgo por geoamenazas** en ductos.
- Completa el ciclo de gestión de integridad: **Inspección, Monitoreo, Obras, Mitigaciones y Riesgos**.
- Su publicación está prevista para el segundo semestre de **2025**.
- Contenido
  - Análisis de riesgo para toma de decisiones
  - Permitirá priorizar inversiones
  - Se consideran todas las amenazas relevantes para los istemas de transporte por ductos.
  - Tipologías de análisis de riesgo
    - Enfoques cuali/cuantitativos
    - Matrices de riesgo
    - Se busca estandarizar la evaluación de la criticidad

06 Consideraciones finales

- Consolidación del conocimiento geotécnico
  - Con esta tercer guía, EPGEO ofrece una visión integral de la geotecnia aplicada a ductos.
  - Las tres guias representan un aporte técnico sin precedentes en la región.
  - Se fortalece la gestión de integridad frente a geoamenazas en toda Latinoamérica.


¡Gracias!

International Pipeline Geotechnical Conference
IPG2025
November 6th – 7th , Bogotá, Colombia

IPG2025-xxx

EPGEO-ARPEL LATIN AMERICA PROJECT: PREPARATION OF TECHNICAL GUIDES FOR MONITORING AND CONTROL WORKS OF GEOHAZARDS IN PIPELINES

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SUMMARY

Since 2014, the Geotechnical Professionals Team (EPGEO) of the Regional Association of Oil and Natural Gas Companies in Latin America and the Caribbean (ARPEL) has been developing a project related to knowledge management for the Oil and Gas industry. This project includes the development of three technical guides related to Pipeline Integrity Management in the event of Geohazards in Hydrocarbon Transportation Systems.

This initiative included development of guides, namely:

i) Guide 1: Monitoring of geohazards for pipeline integrity,
ii) Guide 2: Geotechnical mitigation works on pipelines,
iii) Guide 3: Geotechnical risk in pipelines.

The EPGEO group published Guide 1 in 2016 and presented a paper at the 2017 IPG (IPG2017-2538), Guide 2, completed in 2022, was presented at the 2021 IPG (IPG2021-65014), and Guide 3 will be completed during the second half of 2025, thus concluding the first edition of documents of high technical value and with few precedents worldwide.

These publications present the methodology and content developed for the development of the three guides, which essentially cover monitoring, works, and geotechnical risks in response to the occurrence of geohazards that can affect the integrity of a pipeline transportation system, based on the experience of the Andean region of South America.

It is important to highlight that the main focus of the EPGEO group is to share the experiences of professionals from hydrocarbon transportation system owners/operators in Latin America and the Caribbean regarding best practices for pipeline integrity management in the face of geohazards. In this sense, the dissemination of published works to the technical community is crucial for sharing years of experience from professionals from more than 10 operators, who have poured their expertise into these guides, applying pipeline geotechnics to the most diverse areas and challenges that Latin America and the Caribbean present.

INTRODUCTION

In society, the oil and gas industry plays an important role in the development of various economic models and activities. Therefore, it is an industry that must continuously improve its social, environmental, and technical management processes, as well as its regulatory and safety compliance.

Emphasizing what is described in the summary, the EPGEO has been developing activities since 2013 and has strengthened regional multidisciplinary work, resulting in the publication of various documents at various international events, such as the IPG Conference 2015, IPG Conference 2017, INGEPET 2018, IPG Conference 2021, and IPG Conference 2023; the content of which is included in this document.

As presented at the IPG Conference 2017 [9], in the transportation segment of said industry, it has been identified that the Climate and External Forces Threat has a lower failure occurrence rate than other threats in the world; however, in Latin America the failure rates of pipelines due to geohazards exceed those of other regions of the world [1] due to the susceptibility conditions identified in the Andes Mountains, understood as geomorphological characteristics and adverse triggering agents for the stability of the rights of way [2] [3], which generate a challenge in terms of adequate integrity programs for the management of geohazards in a STD [4] [5]. Since this is not a local challenge, companies in the Latin American region have joined forces to reduce the levels of uncertainty associated with pipeline integrity management in the face of geohazards, with the understanding that the source of lasting competitive advantage is based on knowledge [6]. This dynamic, initially understood for financial markets, applied in this environment of change and new challenges generated by geohazards, presents in this document a successful experience of structuring an interdisciplinary work team that advances on the path of sharing its knowledge and best practices, in what corresponds to the first two objective guides of this group, towards the generation of creative knowledge in what corresponds to the third guide. All of the above, with the purpose of advancing in the risk management due to the threat of Climate and External Forces.

1. COMPOSITION AND OBJECTIVES OF THE GROUP

The Geotechnical Project Team (EPGEO) was formed in 2013 within the Regional Association of Oil, Gas and Biofuels Companies in Latin America and the Caribbean (ARPEL), given the identified need to share the experiences and best practices of transportation operators in the oil and gas industry in the region [9].

This need was first addressed worldwide by the “International Conference on Terrain and Geohazard Challenges Facing Onshore Oil and Gas Pipelines”, organized by British Petroleum (BP) in 2004 in London, and which aimed to share and promote commitment among designers, constructors, environmental and geotechnical specialists, operators, and different organizations, in relation to geohazard management. As a result of this conference, a book with more than 40 articles that present the state of the art and the experience gathered in the field was submitted to the technical literature [7]. With a similar objective to that sought at this Conference, ASME began organizing the “International Pipeline Geotechnical Conference - IPG” in 2011, which this year reaches its fifth edition [9].

At the regional level, the first specific discussion scenario regarding geothreats was presented at the Workshop organized by ARPEL in the city of Medellín (Colombia) in May 2012, with a subsequent workshop being held in Buenos Aires (Argentina) in 2017. It is worth highlighting within these interdisciplinary discussion scenarios the Geology and Geotechnics Meetings organized biennially since 2012 by COGA in Lima (Peru) [9] and most recently by TGP Perú in February 2025.

As a result of this professional exchange, the possibility of developing regional publications that compile these good practices in the form of guides was established, and that would allow the generation of technical literature, beyond articles presented at conferences, and that would document the management of pipeline integrity against geohazards, in order to contribute to the construction of a concept of geotechnics applied to the hydrocarbon transportation sector [9].

Currently, the group is made up of companies from the region that have contributed to the development of Guides 1 [8], Guide 2 [11]. Some of them are: CENIT (Colombia), OCENSA (Colombia), PETROBRAS (Brazil), RECOPE (Costa Rica), TGN (Argentina), TGP (Peru), YPF (Argentina) and YPFB (Bolivia), which are working on the development of Guide 3 for risk management for Geohazards in Pipelines, which will be completed in the second half of 2025.

2. WORK METHODOLOGY

As previously mentioned, the main focus of the EPGEO group is to share the experiences of professionals from hydrocarbon transportation system owners/operators in Latin America and the Caribbean regarding best practices for pipeline integrity management in the face of geohazards. This challenge involves implementing the management of such knowledge [2] in order to transform the tacit knowledge of individuals into explicit knowledge of an organization [6]. In this particular case, the individuals are the transportation operators of each country, and the organization is Latin America and the Caribbean.

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The EPGEO's technical discussion strategy consists of holding virtual meetings in which activities related to the group's general objectives and analysis of the technical documents under development are developed. This allows for sharing lessons

learned and analyzing specific situations that can be adapted to each operator's environment.

Since 2014, nearly 140 videoconferences have been held, highlighting the experience gained and the desire to build new knowledge. Three in-person workshops have also been held in Cartagena (Colombia) in October 2014, in Bogotá (Colombia) in July 2015, and in Buenos Aires (Argentina) in January 2017. These workshops have consolidated the group's spirit and vision and have allowed it to reaffirm the ties of regional integration.

Likewise, computer tools have been used to ensure progress in the development of documents within the group and allow for cross-group review as contributions are made by each member; these contributions are considered at each meeting.

On the other hand, strengthening the technical competencies in geohazards of professionals involved in the maintenance of hydrocarbon pipeline transportation systems for operators in the region was identified as one of the opportunities for improvement in the management of this threat. ARPEL holds this event frequently for those interested in the subject.

These activities reflect the group's interest in becoming an international benchmark in pipeline integrity management for geohazards. This is becoming apparent to pipeline integrity governing bodies, such as those organizing this conference. This effort seeks to sustain knowledge and build scenarios that provide opportunities for continuous improvement.

3. RESULTS

As one of the first results of the group, the Monitoring and Inspection Guide for Pipeline Integrity Management in the Face of Geohazards [8] was published in August 2016 for ARPEL partners, and was presented at the 2017 International Geotechnical Conference [9].

Guide 1 documented best practices and lessons learned in the monitoring and inspection of pipelines, rights-of-way, blasting agents, and ground instability processes that could threaten pipeline integrity. It also identifies geohazards and their relationship to potential loss-of-containment events based on their type and magnitude [8].

Its scope included a description of the geohazards and the mechanisms for supervision and monitoring, their application, as well as: the file and criteria for information management; a description of the supervisions and inspections in which the surface and evidence of instability and ground failure are recognized; ground monitoring, the triggers that materialize the threats and the measurement of the effect of the geohazard on the pipeline, and geographic information systems, as a tool to manage geohazards [8].

At the end of Guide 1 (327 pages), specific experiences of applying the techniques were consolidated, to provide greater clarity and applicability of the concepts.

List of geological risk Geotechnics:

- Landslides and other mechanisms (creep, flows, etc.)
- Hydrotechnical: river crossings (scours, floods, avulsions, encroachments)
- ROW erosion: longitudinal, gullies, waves and wind, settlement
- Earthquakes: faults and liquefaction
- Meteorological: thunderstorms, lightning Rest of the World Survey
- Ground monitoring and survey
- Triggering factors
- Pipeline monitoring (Applied GIS)
- Applied solutions to improve pipeline integrity against geological hazards

In August 2023, Guide 2 (202 pages) was published for ARPEL members, related to Geotechnical Mitigation Works in Pipelines [11], which was prepared mainly through the use of technological tools through virtual meetings to exchange experiences and discuss the contents of the guide, which was carried out in at least 60 videoconferences in the last three years.

This second guide is divided into chapters: Introduction, Glossary, Pipeline Design, Pipeline Construction, Operation and Maintenance, Technical Abandonment of the Pipeline, Applied Geomatics, and Case Studies.

List of work

Surface drainage
- Subsurface drainage
- River crossings
- Landslide stabilization
- Offshore pipelines
- Special works (tunnels, HDDs, bridges, etc.)
- Pipeline design
- Construction
- Operation and maintenance
- Technical abandonment of oil pipelines
- Applied geomatics Field cases

This chapter structure shown in Figure 1, takes into account two main axes, the Description of the Works (Chapter 3) and the Asset Life Cycle (Chapters 4 to 7), such that, in each of the stages of the cycle, the most representative works for management against geothreats can be observed, just by mentioning them with respect to what was presented in Chapter 3.

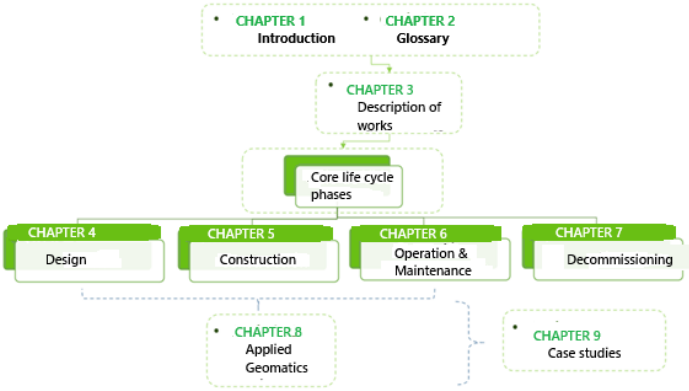

FIGURE 1. Relationship between the chapter structure of the Guide and the Asset Life Cycle. Source: EPGEO (2023).

Regarding Chapter 3, the Description of the Works was structured in such a way that a relationship of use and type could be established, as a practical classification for the reader, as presented below:

- Drainage management works (surface, subsurface, at river and stream crossings)
- Stabilization works
- Underwater pipeline works

Finally, Chapter 8 stands out, focusing on the application of Geomatics principles in Geohazard Management, and Chapter 9, as a compendium where some of the experiences of the companies that participated in the development of Guide 2 are shared.

Thus, this guide 2 consolidates best practices, lessons learned, and alternatives for implementing civil and geotechnical works to prevent, mitigate, or correct the actual or potential impacts of geohazards on hydrocarbon transportation systems.

It also aims to generate a compendium of stabilization and control measures, construction processes, and methodologies for addressing existing problems in the industry, in order to evaluate their effectiveness and appropriate scope of application. Finally, it aims to promote the application of knowledge in Geomatics to enable the development of applications and information systems for the traceability of technical information and support in decision-making.

In this way, and based on the expertise of each participating operator through their specialists, a document was created with valuable reference information for any pipeline geotechnical or integrity professional who requires it, and with the support of professionals with extensive experience in the industry.

4. UPCOMING CHALLENGES

Based on the experiences gathered from previous exercises, given the continuity of the EPGEO, and reaffirming the usefulness of these tools to the technical and operator community in managing pipeline integrity against geohazards, the EPGEO maintains its goal of completing the trilogy of guides, with the third to begin, referring to geohazard risk analysis.

Currently, risk-based analyses are the fundamental decision-making axis when evaluating business-sensitive issues and defining investment prioritization. To achieve this, risk analyses are typically performed considering all threats to asset integrity [10].

Qualitative and quantitative analyses predominate in the guide. Furthermore, the risk matrices used were largely developed by each operator to establish parameters that define the criticality of a failure and properly weight it according to a specific standard without depending on the evaluator's judgment.

With the completion of the third guide, the full spectrum of pipeline geotechnics will be covered: Inspection, Monitoring, Construction, Mitigation, and Risks.

5. EXAMPLES

Below are some examples of geotechnical process control and mitigation techniques, as well as civil works referenced in Guide 2.

FIGURE 2. Riverbank defense with concrete blocks. Source: Specialized web site.

FIGURE 3. Riverbank defense with concrete dice
Source: Specialized web site

FIGURE 4. Horizontal drain collection chamber for piezometric level reduction. Source: Specialized web site

FIGURE 5. Concrete mats for slope protection.
Source: Specialized web site

FIGURE 6. Concrete mats for water control.
Source: Internet (2020).

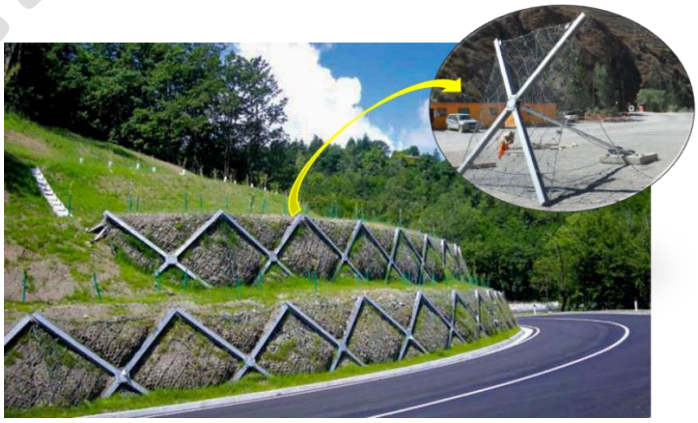

FIGURE 7. ERDOX technique for slope stabilization
Source: Specialized web site

6. ACHIEVEMENTS OBTAINED

The development of Guide 1 and Guide 2, already published, met the expectations of those involved in their development, the Latin American technical community, and various companies developing geotechnical solutions, who saw them as a reference and support tool for the development of new products and technologies.

On the other hand, the years of research leading to these publications have helped us understand the various problems of geographic diversity found in Latin America. Peru, Colombia, Ecuador, Bolivia, Brazil, Costa Rica, and Argentina shared insights and feedback from each country's experiences, mistakes, and achievements, along with all that this entails. We were able to understand the different names for protective elements, works, or geographical features, which enhanced our vocabulary and helped improve our understanding and general knowledge.

Last but not least, it has allowed for the creation of important connections between companies and individuals, reflected in the excellent relationship that the EPGEO team has been strengthening.

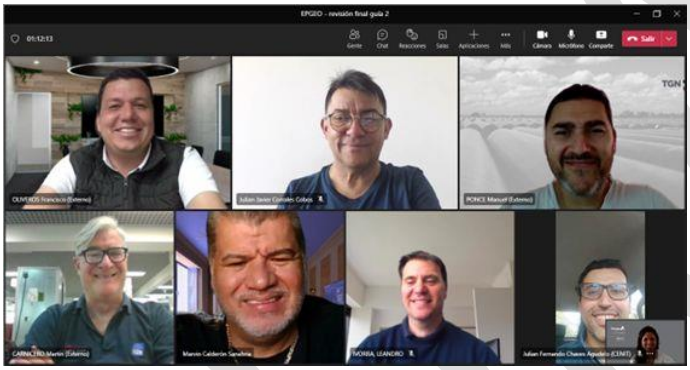

FIGURE 8. Virtual meeting example
Source: EPGEO (2020).

7. CONCLUSIONS

As concluded in guide 1 [9], the knowledge to manage geohazards is dispersed in the experiences of operators and in technical books that do not focus on the particular conditions that arise in hydrocarbon transportation systems, so it is necessary to consolidate them in a group of guides that facilitate the Integrity management of maintenance professionals in the face of the action of geohazards in all stages of the transportation business, and result in a shared vision of their understanding in a particular regional context.

In this way, strengthening communication mechanisms between operating companies and owners of hydrocarbon pipelines in the region has allowed for the systematic application of a knowledge management methodology that can positively influence companies at the regional level and contribute to the proper management of events that negatively impact the integrity of the transportation infrastructure.

By applying the knowledge gathered by this group, we seek to contribute to reducing the rate of containment losses due to geohazards in the region. This is based on an adequate monitoring program for the ROW and pipeline, appropriate risk assessment techniques for geohazards, and an effective ROW intervention program through civil and geotechnical works.

8. THANKS

To Irene Alfaro, as Senior Managing Director of ARPEL, for her vision of the EPGEO team, as well as to ARPEL for its coordination, logistical and IT support.

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To the EPGEO team, for sharing their experience, for their time, for their professionalism and for their human qualities, without which this objective would not be possible:

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- Hugo García OCENSA – Colombia.
- Manuel Ponce and Martín Carnicero TGN – Argentina.
- Leandro Ivorra YPF – Argentina.
- Carolina Araujo and Marcelo Langone PETROBRAS – Brasil.
- Marvin Calderón RECOPE – Costa Rica.
- Mario Haderspock and José Carlos Holters YPFB – Bolivia.

Finally, and in common for all, we would like to highlight the selfless participation of each of the authors of this guide, who have dedicated extra time from their regular schedules to collaborate with such important geotechnical reference material.

9. REFERENCES

[1] Sweeney, M (2004). Terrain and Geohazard Challenges facing onshore oil and gas pipelines: Historic Risks and modern responses. Proceedings of the International Conference on Terrain and Geohazard Challenges Facing Onshore Oil and Gas Pipelines. Pg. 641-659. London, UK.

[2] Aristizábal, Jaime y Rojas, Janeth (2015). The Management of the Threat of Climate and External Forces based on the

Knowledge Management. Proceedings of the ASME 2015 International Pipeline Geotechnical Conference. Bogotá, Colombia.

[3] García, H y Contreras, M (2015). Guía Arpel para el Monitoreo de Tubería, Derecho de Via y Agentes Detonantes en la Gestión de Integridad de Oleoductos y Gasoductos frente a las Geoamenazas. Proceedings of the ASME 2015 International Pipeline Geotechnical Conference. Bogotá, Colombia.

[4] Aristizábal, Jaime; Chaves, Julian (2015). Overview of the Risk Management Strategy of Climate and External Forces Threat in VIT-Ecopetrol. Proceedings of the ASME 2015 International Pipeline Geotechnical Conference. Bogotá, Colombia.

[5] García H., Nieves C. & Colonia J. Integrity management program for geo-hazards in the Ocensa pipeline system. International Pipeline Geotechnical Conference, IPG 1918-2013. Bogota, Colombia. 2013.

[6] Nonaka, Ikujiro; Takeuchi, Hirotaka (1995). The knowledge creating company: how Japanese companies create the dynamics of innovation. New York: Oxford University Press. p. 284. ISBN 978-0-19-509269-1.

[7] Sweeney, M - Editor (2004). International Conference on Terrain and Geohazard Challenges Facing Onshore Oil and Gas Pipelines: Evaluation, Routing, Design, Construction, Operation. BP Conference. P. 736. ISBN-13: 978-0727732781 and ISBN-10: 0727732781. London, UK.

[8] ARPEL/EPGEO (2016). Guía Monitoreo e Inspección en la Gestión de Integridad de Ductos frente a las Geoamenazas. Montevideo, Uruguay

[9] Aristizábal, Jaime; García, Hugo. ARPEL/EPGEO - Regional Geotechnics Project: Good Practices In Pipeline Integrity Management to Face Geohazards. Proceedings of the ASME 2015 International Pipeline Geotechnical Conference. Bogotá, Colombia.

[10] ASME (2014). ASME B31.8s "Managing System Integrity of Gas Pipelines". Integrity Threat Classification.

[11] ARPEL/EPGEO (2023). Guide for the execution of civil and geotechnical works in the management of the integrity of hydrocarbon transport pipelines against geohazards. Montevideo, Uruguay