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Social exploration in geothermal energy. How to do it?

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INTRODUCTION

According to Jácome Paz and Rodríguez Gómez (2025) social exploration means studying, understanding and engaging in dialogue with the socio-environmental context of a geothermal resource. Any geothermal project should include participatory activities where basic geothermal concepts are shared, preferably, information referring to the geothermal source which is being studied and to which the community might already have knowledge about; however, an important information to be conveyed to the local population is the exploitation process, because they probably know the surface manifestations but it is very likely that they may have misleading information about what processes the exploitation activities are. In addition, perception studies addressing the community's relation with the environment, including geothermalresources,s should be undertaken. Therefore, the approach with society during a geothermal project should not be limited to an exploration tool for the social acceptance of geothermal energy, but rather conceived as a strategy to enhance and strengthen the community involvement and participation within the impacted territories. Furthermore, social exploration must be carried out to avoid possible socio-environmental conflicts due to misinformation about the activities that are involved in resource development.

Most of this research and proposal is based directly from firsthand experiences that have provided the authors with a comprehensive understanding of territorial dynamics, particularly in territories facing conflicts related to geothermal energy or even the development of other types of resources, whether due to historical, cultural, or informational factors. All of these experiences have taken place within Mexico.

This work aims to present and summarize, in a schematic way, the essential elements that geothermal exploration should include in an area under investigation. It is important to remember that standardizing this task is inherently complex, since each country may have different legal frameworks for addressing social impacts depending on the education level of the population, and each territory will have its own level of acceptance and understanding of geothermal energy. Consequently, the actions to be taken will vary from one territory to another and must be adapted to the particular characteristics and socio-environmental context of each territory.

1 METHODS & RESULTS

The general methodology carried out was as follows: 1) compilation of outreach strategies with society. 2) Case studies with developed materials and strategies. 3) Analysis of the information, including comparisons and classification of types of material. 4) A schematic proposal of a basic methodology or outline, in the form of Best Practices for conducting Social Exploration.

1.1 Collection of Methods

The types of materials and practices identified are classified as follows:

- General outreach materials, without a specific target audience.
- Outreach materials contextualized to a particular area and audience.
- Materials related to social impacts, which may include social impact assessments, surveys on community perception of impacts.
- Activities related to the social appropriation of the project, meaning technical/economic appropriation by society. In some cases jobs creation or inclusion of the communities with bonds sharing.
- Geothermal internships that can link the academic personnel with the community.

1.1.1 General Outreach

This type of outreach strategy is implemented in any location with or without geothermal manifestations, without any particular or contextualized focus. The strategy encompasses educational materials and participatory activities aimed at conveying fundamental concepts of geosciences, geothermal resources, and their potential applications. These materials may include diagrams, infographics, posters, mock-ups, crosswords, and other interactive tools designed to facilitate understanding and engagement. However, by using highly general geothermal schemes, there is no motivation for the public to identify and understand local geothermal resources.

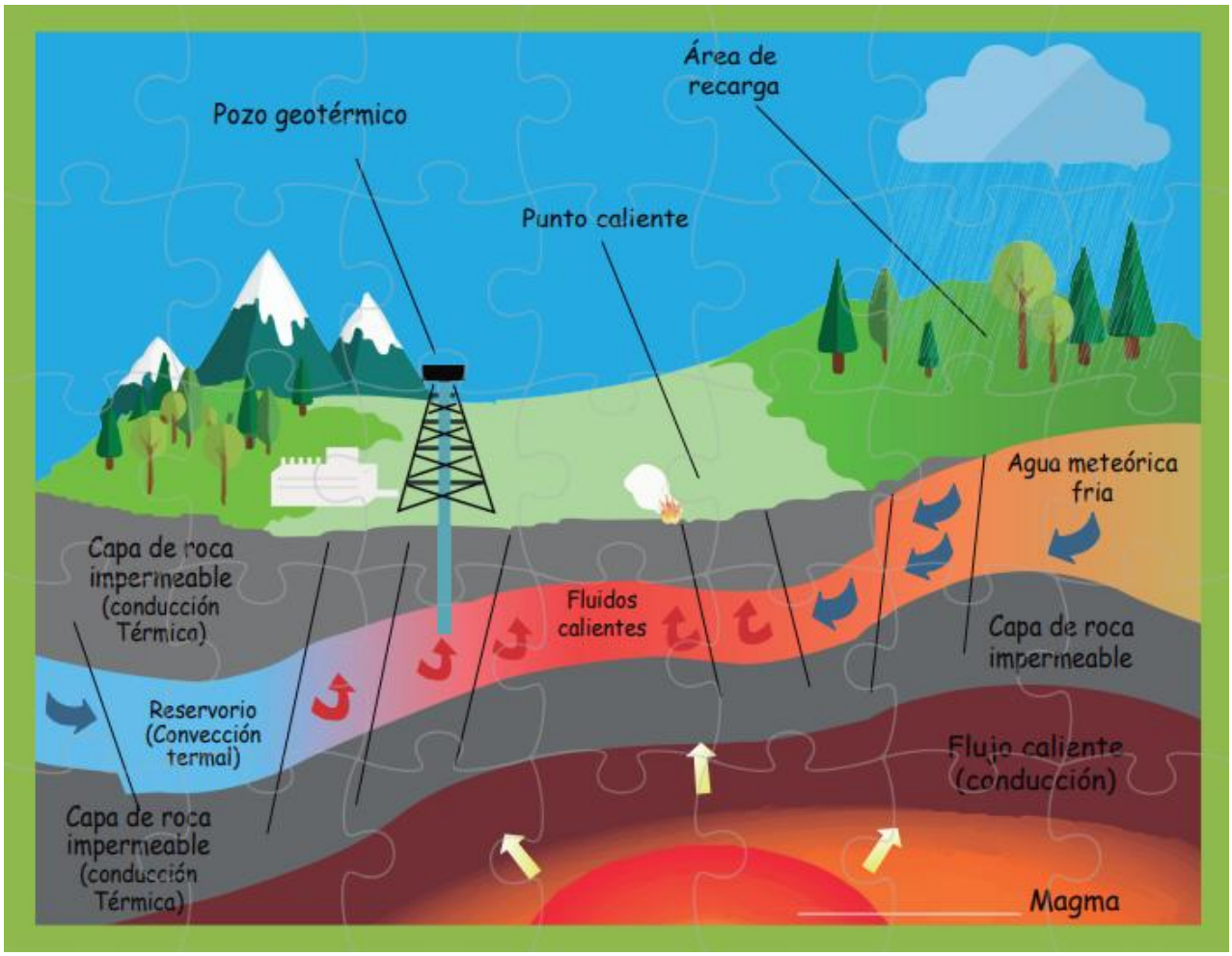


Figure 1. Example of general outreach material. Puzzle illustrating the simplified components of a convective-type geothermal system (example in Spanish).

1.1.2 Focused Outreach

This type of outreach usually includes adapted versions of the previously mentioned materials, incorporating local names and photographs, as well as geological, geochemical, and geophysical information specific to the area, alongside relevant historical references. It also involves the identification of key community stakeholders, such as community leaders, school directors, and other local representatives, along with the determination of the most effective communication channels.

Usually this type of activities are done in local education facilities (schools, auditoria, libraries, etc) to gather children, young people and their parents and teachers, as this increases the spreading effect of the information. It is important to note that if this type of outreach strategy is not preceded by basic geothermal concepts and previous visits to the community, it may have information gaps or be perceived as a potential social and territory disturbance.



Figure 2. Examples of contextualized outreach materials. These materials were created for the central region of the state of Veracruz, where geothermal exploration and contextualized outreach activities were carried out. Material taken from Jácome Paz et al. 2024.

1.1.3 Social impacts evaluation

The social impact of geothermal development should be presented through all the benefits that can bring to the community, because most of the time, the benefits are not directly presented to the community by the developing companies. The jobs and infrastructure creation bring an increase in the economic level of the communities in the area, that very often are located in economically depressed areas, where jobs are scarce and families live out from governmental aid. The construction of a plant/direct use installation is always linked with roads, clean water, and other facilities that are lacking in many areas with geothermal prospects. However, it is important to consider that the social impact evaluation is related to social perception and traditional lifestyles. Meaning that the material benefits from a geothermal development, are not always perceived as benefits if the community and their traditions are not included in the decision making and operation of a project.

In Mexico, social impacts in energy projects are addressed through two main participatory mechanisms. The first is the Social Impact Manifestation (Manifestación de Impacto Social, MIS, before EVIS), mandated by the Hydrocarbons Law (2014) and regulated by the Ministry of Energy (SENER), which requires project developers to identify affected communities and propose a Social Management Plan. The second is the Indigenous Consultation, grounded in Article 2 of the Mexican Constitution and ILO Convention 169, coordinated by the National Institute for Indigenous Peoples (INPI) together with sectoral authorities; this mechanism is activated when a project may affect the rights, lands, or resources of Indigenous communities and must be carried out in a *free, prior, informed, culturally adequate, and good-faith* manner. In practice, these consultation mechanisms often fall short of their intended goals. The MIS process tends to be highly technical and are frequently treated as formal requirements rather than genuine spaces for dialogue.

Moreover, it should be noted that for geothermal energy direct use projects, included in the new legal framework (the 2025 Geothermal Law), there are no clear procedures to incorporate social impacts into project design. In this context, it is ethically essential for any working group operating in a territory to develop participatory projects and engage in sustained dialogue with local communities. As an academic exercise, a thesis was carried out in which an adaptation to the EVIS Forms (now MIS) for direct uses was suggested (Olmedo Velázquez, 2024). This constitutes a proposal of basic steps to understand and work with the community where the project is intended to be developed. The proposed format is not meant to be a requirement but rather a guide for participatory work and for creating spaces for co-creation.

1.1.4 Social Appropriation

In Jácome Paz and Rodríguez Gómez (2025), social appropriation is defined as the process by which a social group adopts technical knowledge and gains the capacity to make decisions regarding a geothermal resource or project. This form of appropriation is typically cognitive and results from a series of targeted, gradual activities, such as workshops and training sessions.These activities should go hand in hand with the direct uses of geothermal energy or with whichever project is intended to be developed.

The appropriation of a resource by the communities arrives when they consider the project as their own and will defend it from groups that might want to take some political or economic gain without being involved. The strategy must include a clear long term analysis and visibilization of the benefits and in which manner it will continue to involve the community, instead of temporary apparent benefits (e.g. pantry distribution).

1.2 Best Practices in Social Exploration

Analyzing all of the above, it is possible to propose a guide of basic actions or best practices to be carried out during geothermal exploration work aimed at establishing a project in the territory. All of these actions together are what we refer to as *Social Exploration*.

The best practices in Social Exploration must include plenty of information for and from the community, creating spaces for dialogue and participatory projects. To generate these co-creation spaces and complete geothermal projects in benefit of all involved stakeholders, this work proposes an 11 steps framework.



Figure 3. Best practices in social exploration framework

According to Fig 3 there are some basic steps in geothermal exploration (1-2), parallely, there are some basic steps to identify social context, territorial actors and social perception of the community (2-7). During these activities, general outreach activities can be carried out as a strategy to generate dialogue while getting to know the community. Moreover, we believe that, in order to increase the viability of geothermal projects in local communities, it is important to undertake social exploration actions with the explicit goal of disseminating and raising awareness about geothermal resources and its uses.

Following a general outreach phase and the identification of leaders and territorial actors, it is highly recommended to implement a focused outreach effort that addresses the specific characteristics of the geothermal manifestations, their locations, and the associated community traditions, ancestral knowledge, legends, and uses of the resource. The importance of this approach lies in fostering familiarity, connection, and a sense of shared interest within the community toward their geothermal environment.

After the technical exploration is concluded and before starting the development of any project, viable projects can be presented to the community,, and through dialogue, jointly select the one(s) with the most interest. It is also important that the community is aware of the possibilities a project can generate for them, such as, employing during the exploration phases, capacitation and job creation during the operation, or even participation as stakeholders of the project. At this point any other social impact of the potential project must

be identified and dialogued in a participatory way with the community, as well as, activities for social appropriation.

In addition, long-term regional strategies must be incorporated with the aim of highlighting community needs for the development of geothermal projects to co-create better strategies.

As an example we can mention the Geothermal Internships carried out in 2024 and 2025, sponsored by different entities including the IGA during 2024. This project aims to foster regional collaboration and inter-disciplinary training by connecting Geothermal Actors (e.g., academic institutions, geothermal companies, geothermal power plants, direct-use cooperatives, and communities interacting with geothermal areas) with motivated young professionals of the geothermal sector. The program has successfully completed two iterations, benefiting numerous young people across Latin America. A key pillar of these internships is to highlight the importance of social context in geothermal projects. Through community visits, students are exposed to non-technical challenges participating in diverse general and focused outreach activities targeting different sectors within a geothermal area. These experiences enhance their networking and communication abilities, as well as their understanding of territorial dynamics.

2. Discussion & conclusions

The analysis presented in this work, highlights social exploration as a fundamental component for geothermal development, one that must be approached with the same level of importance and structure usually reserved for geological, geochemical and geophysical exploration. Different styles of outreach material and strategies show that effective engagement must move from general one-way information sharing to contextualized, territory-specific communication which aims to integrate cultural narratives, local terminology and site-specific scientific data. Through this style of two-way information sharing and participatory approaches, the community's existing relationship with the geothermal resource is addressed in a manner that addresses misconceptions and historical tensions, while promoting resource appropriation.

Overall, this study underscores that social exploration must be applied as a bidirectional, long-term process that merges scientific knowledge with local experience, provoking genuine spaces for dialogue beyond only legal requirements. Keeping in mind that the goal is not simply for social acceptance but community appropriation, in which local communities recognize long-term benefits, participate actively in project developments and co-create solutions.

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