ABSTRACT

Critical research challenges within the Earth Sciences include the quantification of Earth's dynamic processes on all scales, as well as geohazards and georisks, the assessment of environmental quality, the development of models for exploration and sustainability of geological and water resources in an advanced economy, the energy transition in times of global change, the development of advanced models for environmental management and the measurement of the impact of global change, among others. Scientific advance in these areas, together with the understanding of their connections, are essential for the sustainability of our society as a whole.

KEYWORDS

Planet Earth | geosciences | geodynamics | georesources | water resources | air quality | geohazard | global change | environment | geoheritage | planetary geology

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EXECUTIVE SUMMARY

During the last few decades, Earth sciences have evolved rapidly and are now able to produce scientific models that can help to reconstruct and forecast the past and future processes of the Earth system. This includes forecasting the future behavior of geological systems, and also the prediction of future geological patterns. But these models need high quality observations for their development and validation. Every day human activities involve interaction with our planet Earth. Everything around us is built upon the Earth, grows on Earth, or depends on the environments and internal dynamics of the Earth to some degree, even humans, or specially, humans. Every parcel on land belongs to a hydrological basin. The structure and processes occurring at the interior and on the surface of our planet Earth have strong relevance for humanity's basic needs, such as supply of water and resources, protection against the effects of natural hazards, and control of the environmental degradation on the Earth. Therefore, the knowledge about the Earth is the key to develop an informed citizenry and a global awareness of a common Planet and a common future.

Most important challenges posed by our modern society that wants to be safe and sustainable in its immediate future cannot be addressed without the direct contribution of geosciences, and in this sense, it is essential to create public awareness of geoscience's vital role to society. The increasing pressure that we are placing upon the environment makes us increasingly vulnerable, as evidenced by global assessments (IPCC, 2018; IPBES, 2019; UN Environment, 2019). As it was already stated during the International Year of Planet Earth 2005-2007, we have an urgent need for scientifically advanced "geo-prediction systems" that can accurately locate subsurface resources and forecast the timing and magnitude of earthquakes, volcanic eruptions and land subsidence (some of which is caused by human activity) (www.esfs.org). The design of such systems poses a major multidisciplinary scientific challenge. The complexity in the prediction of Earth processes also imposes important constraints on predictions in oceanographic, hydrologic, and atmospheric sciences, including climate variability (Fig. 1) and its subsequent impacts on anthropogenic environments, population exposure and human health. At the same time, hydrologic and atmospheric processes have direct critical interactions with life and climate. Therefore, it is crucial to recognize the key role of geosciences to ensure the sustainable development and exploitation of our planet resources. A review of the Sustainable Development Goals defined by the United Nations as the blueprint to achieve

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a better and more sustainable future for all humankind, show that they are intimately related to or depend on our current and future knowledge on the structure, evolution, and dynamics of our planet.

FIGURE 1. Simplified pictogram showing the basic framework for global tectonics and geological environments, cast into the whole Earth system, and extending into the Solar system, and galaxy (Van Wick de Vries *et al.*, 2018)

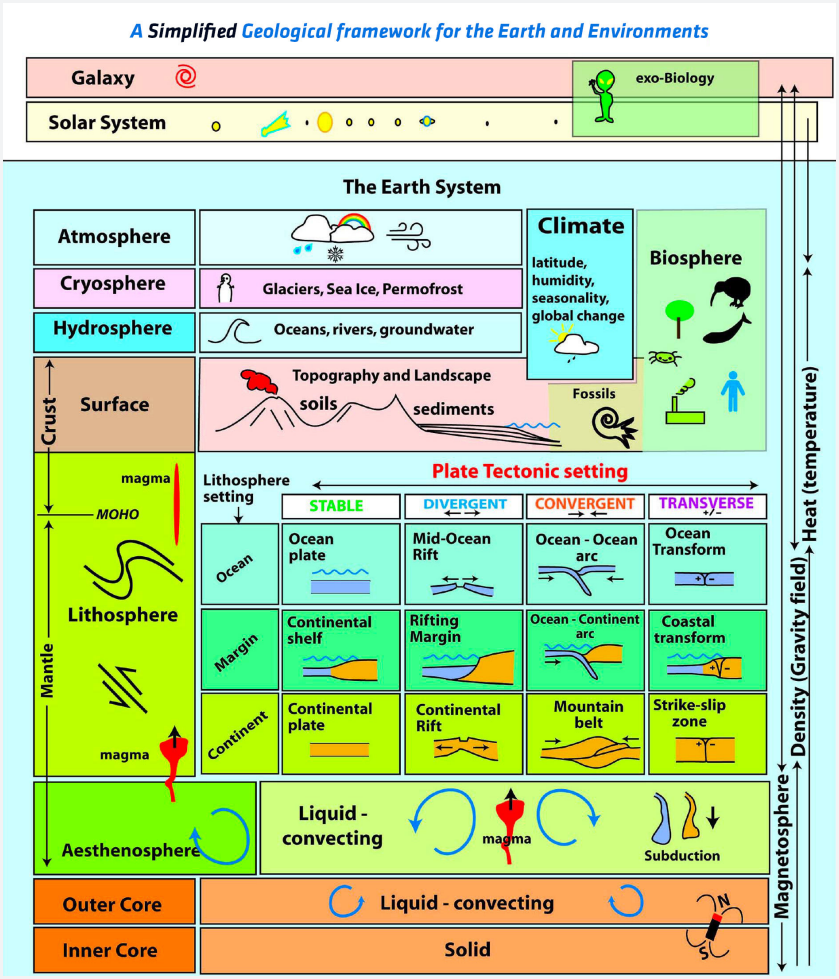

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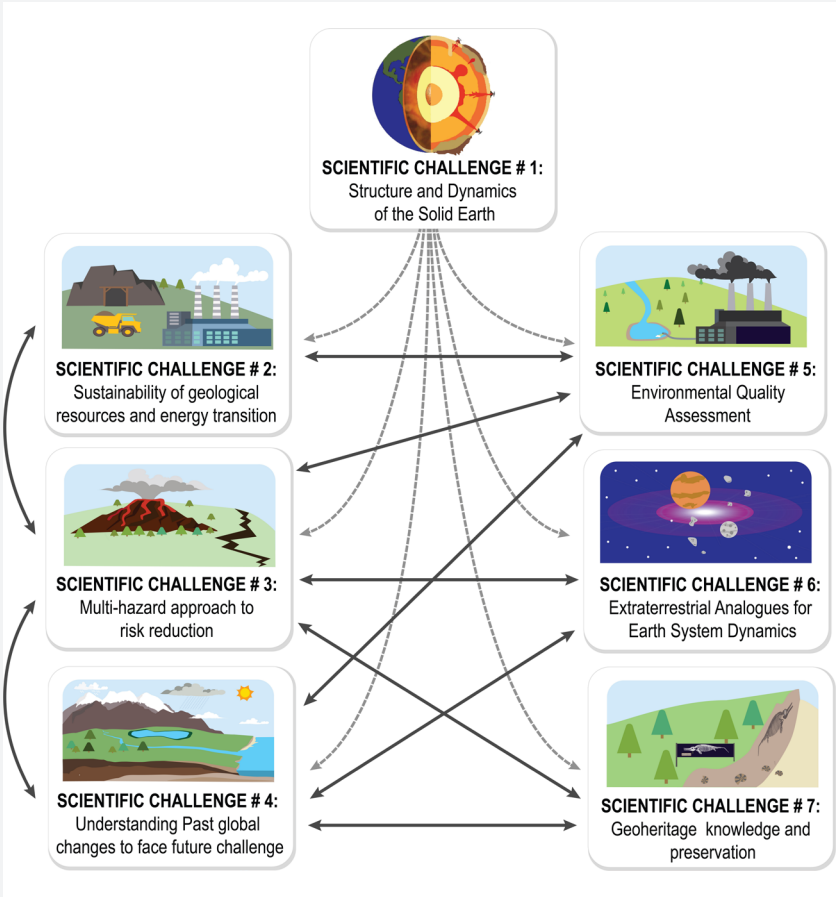
FIGURE 2. Interrelation between challenges included in Strategic Theme #14



Predicting the behavior of geological systems requires observing the present and reconstructing the past. This implies the study of both ancient and currently active processes that have contributed to the present day Earth. To maximize the benefit, CSIC scientists must investigate these processes wherever they are active or preserved in the past, regardless of geographic or political boundaries. In this sense, this Strategic Theme aims, through observation and modeling, to generate fundamentally new conceptual developments addressing the main challenges imposed by our society in relation to the planet Earth. A corollary to this is the continued internationalization of CSIC's

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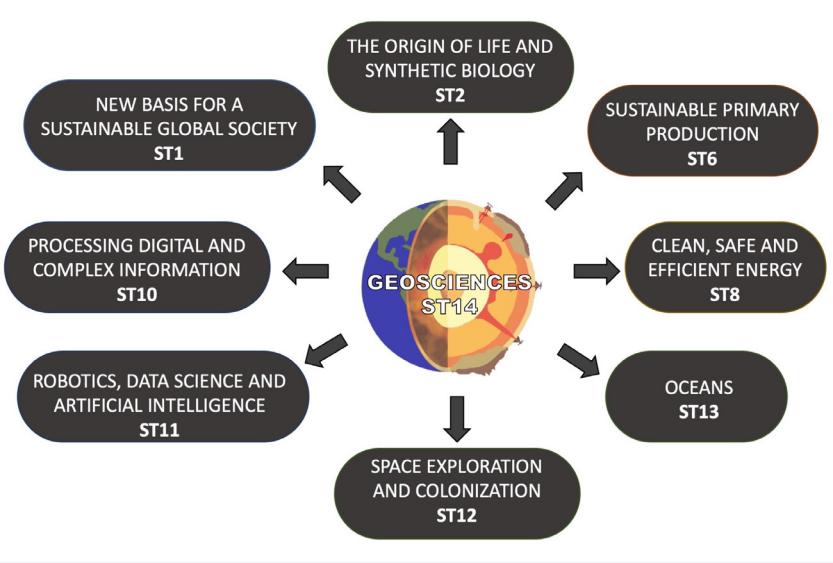
geoscience program through leading edge research and the stimulation and support for placing its geoscientists in international leadership roles. While there are many world- class scientists and labs in Spain, and in the CSIC in particular, there are still very few leaders of international organizations, decision-making bodies, journal editors, etc. This is also a clear challenge in the Spanish geosciences that we also plan to face within this Strategic Theme.

FIGURE 3. Cross-links of Geosciences Theme with the other Strategic Themes



In order to make this Strategic Theme successful, seven scientific challenges have been identified (Fig. 2), each of them including several key challenging points that correspond to the most urgent and necessary aspects to be developed from a geoscience perspective in the mid to long term. All scientific challenges share knowledge and methods, so transversality inside this Strategic Theme and among all participating will be maximized (Fig. 2).

In the same way, this Strategic Theme shares interests and objectives with other CSIC Strategic Themes, so full collaboration between them will be also promoted (Fig. 3). This will also contribute to enhance international collaboration and to increase our participation in international research programs and projects.

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INTRODUCTION **REFERENCES**

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