

# Natural Hydrogen in China: Distribution Patterns, Genesis Mechanisms, and Exploration Opportunities in Complex Geological Settings

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China's abundant geological resources provide a unique framework for the formation, accumulation, and exploration of natural hydrogen, a promising clean energy source with low production costs and minimal environmental impact. This study systematically examines the distribution characteristics and exploration potential of natural hydrogen across China by integrating geological, geochemical, and tectonic data with global analogs. The genesis of natural hydrogen in China is classified into three categories: inorganic (e.g., serpentinization and radiolysis), organic (e.g., biodegradation of hydrocarbons), and mixed processes. Key formation mechanisms include water–rock interactions, deep crustal degassing, microbial activity, and fault-related hydrogen migration. Our research identifies four major types of hydrogen-enriched geological environments in China: (1) stable Precambrian iron-rich basins, such as the Tarim and North China Craton; (2) active rift basins, including the Songliao and Bohai Bay Basins; (3) fault-controlled zones, exemplified by the Tan-Lu and Altyn Tagh faults; and (4) magmatic regions, notably in the Tibetan Plateau and its margins. Field measurements reveal hydrogen concentrations exceeding 40% in some regions, highlighting the significant resource potential. Compared to international counterparts, China's unique geodynamic history, characterized by plate subductions, orogenic cycles, and magmatism, offers unparalleled opportunities for hydrogen accumulation. The study's key contributions lie in: (1) delineating the spatial distribution of hydrogen resources in China through a comprehensive geological framework, (2) clarifying hydrogen formation and migration mechanisms under varied geological conditions, and (3) proposing exploration strategies based on tectonic activity, basin evolution, and fault dynamics. These findings not only enhance the understanding of hydrogen-rich geological systems but also establish a scientific basis for large-scale exploration and development. This research provides critical insights into the role of natural hydrogen in the global energy transition and underscores China's potential to lead in this emerging clean energy frontier.

