# Identification of Thermal Hazard-Inducing Structures and Risk Assessment in Deep Tunnels: Postprint

**Authors:** Zhang Shishu, Zhao Xiaoping

**Date:** 2025-08-20T00:00:00+00:00

## Abstract

Geothermal hazards induced by abnormal ground temperature represent a major technical challenge in tunnel construction, encompassing disaster sources such as hot water and gas, transport pathways, dynamic mechanisms, and engineering indicators, with disaster characteristics including strong concealment, high suddenness, and complex disaster mechanisms. To identify the disaster-inducing structures of tunnel geothermal hazards and quantitatively assess their risks, a technical system of "regional geothermal geological background analysis - multi-stage targeted identification at tunnel site - geothermal hazard risk assessment" was established. First, addressing the fact that regional-scale geothermal geological characteristics determine the scale of disaster sources, a regional-scale disaster-inducing structure identification technology based on regional geothermal field characteristics and geological-geothermal coupling relationships was established to facilitate the selection of suitable "low-temperature corridors." Then, addressing the fact that tunnel-site-scale disaster-inducing structures determine disaster locations, geological-geothermal collaborative investigation techniques—including geochemical tracing, comprehensive geophysical exploration, and drilling during the survey and design stages—along with static assessment methods for geothermal hazard risks were proposed, enabling preliminary identification of thermal convergence characteristics such as "thermal recharge, thermal sections, and thermal phenomena" in tunnels and static assessment of thermal risks. Finally, for potential high-temperature sections, multi-phase thermal parameter tracking monitoring technologies—including borehole rock temperature, hydrochemical characteristics, gas types and concentrations during the construction stage—along with dynamic assessment methods for thermal risks were proposed, enabling advanced targeted identification of thermal convergence characteristics such as "thermal degree, thermal scale, and thermal grade" in tunnel high-ground-temperature sections and dynamic assessment of thermal risks. Meanwhile, future research trends for geothermal hazard identification and risk assessment technologies in abnormal ground temperature tunnels were also discussed. The research results provide a new technical system for geothermal hazard prevention and control in tunnels and offer guiding significance for safe tunnel construction.

## Full Text

## Hazard Structure Identification and Risk Assessment of Thermal Disasters in Deep-Buried Tunnels

**ZHANG Shishu, ZHAO Xiaoping**
PowerChina Chengdu Engineering Corporation Limited, Chengdu 610031, China

### Abstract

Thermal hazards triggered by geothermal anomalies constitute a major technical challenge in tunnel construction. These hazards encompass sources of hot water and gas, transport pathways, dynamic mechanisms, and engineering precursors, with disaster evolution characterized by strong concealment, high suddenness, and complex mechanisms. To identify the disaster-causing structures of tunnel thermal hazards and quantitatively assess their risks, this study establishes a technical framework comprising "regional geothermal geological background analysis, multi-stage targeted identification at the tunnel site, and thermal hazard risk assessment."

At the regional scale, where geothermal geological features determine the magnitude of disaster sources, a regional-scale identification technique for disaster-causing structures is developed based on characteristics of the regional temperature field and geological-geothermal coupling relationships. This facilitates the selection of appropriate "low-temperature corridors." At the tunnel site scale, where disaster-causing structures determine the locations of disaster occurrence, collaborative geological-geothermal investigation techniques—including geochemical tracing, comprehensive geophysical exploration, and drilling—are proposed for the investigation and design phase, along with a static thermal hazard risk assessment method. This enables preliminary identification of heat convergence characteristics such as "heat supply, thermal sections, and thermal phenomena," and static assessment of thermal risks.

For potential high-temperature sections, multi-phase thermal parameter tracking and monitoring techniques are introduced during the construction phase, encompassing borehole rock temperature, hydrochemical characteristics, and gas types and concentrations, together with a dynamic thermal risk assessment method. This achieves advance targeted identification of heat convergence characteristics including "heat intensity, heat scale, and heat level"in high geothermal temperature sections, and dynamic assessment of thermal risks. Furthermore, future research trends for thermal hazard identification and risk assessment technologies in geothermal anomaly tunnels are discussed. The research results provide a novel technical system for tunnel thermal hazard prevention and control, offering guidance for safe tunnel construction.

**Keywords:** tunnel engineering; geothermal anomaly zones; thermal hazards; disaster-causing structures; risk assessment