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Impact of geothermal well testing on exposed vegetation in the Northern Negros Geothermal Project, Philippines

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Abstract

The impact of geothermal fluid discharges during the testing of Pataan 5-D well was evaluated on seedlings of mahogany (*Swietenia macrophylla* King) at various distances from the well and on natural forest vegetation around the wellpad. The parameters measured were: (1) geothermal brine spray concentration; (2) plant concentration of geothermal signature ions (B, Cl, Li and Na); (3) symptoms of plant damage; and (4) plant recovery. Meteorological parameters were also gathered. Adverse effects on the test plants were observed at distances of 5–50 m from the well silencer for over-spray during the horizontal discharge and at 50–350 m from the wellhead during the vertical discharge. Salinity was identified as a significant cause of plant damage. Observed symptoms of damage included drying of leaf tissues expressed as necrotic areas, which occurred first at the tip of older leaves and progressed along the margins as severity increased, resulting in abnormal defoliation. Recovery of seedlings and natural vegetation from sprays was observed in both vertical and horizontal discharges.

Keywords: Geothermal discharges; Environment; Vegetation; Defoliation; Salinity; Northern Negros; Philippines

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1. Introduction

Well testing is conducted during the exploration and development stages of a geothermal project to characterize the physical and chemical properties of the geothermal fluids produced, the permeability and fluid state of the reservoir, and the power potential of the wells. During well testing, geothermal fluids are often released into the atmosphere at relatively high temperatures and pressures. The fluids contain salts (mainly sodium chloride) and elements such as arsenic, boron and lithium, which may have a detrimental effect on sensitive plants that have been in contact with geothermal spray. There is, however, little information in literature on the effects of geothermal discharges on vegetation, despite its importance in forested geothermal areas where there is a growing concern for biodiversity and life-support systems in the environment.

The objective of this study was: (1) to document, characterize and evaluate the impact of both vertical and horizontal discharges on exposed vegetation during testing; (2) to identify the causes of any damage; (3) to determine the resistance threshold of exposed plant species as regards the levels of relevant chemical elements; and (4) to determine the allowable duration of discharge without mitigation before terminal damage affects exposed plant life.

2. Methodology

2.1. Study site

The study was conducted in the vicinity of well PT-5D, located in the Pataan sector of the Northern Negros Geothermal Project in Negros Occidental, Philippines (Fig. 1). The well was completed in February 2001 and has a vertical depth (vd) of 2250 m. Produced fluids (steam + neutral-pH brine) are mainly from a depth of about 2150 m (vd), where the reservoir has a temperature of about 290 °C. When fully opened, the well discharges at a rate of approximately 60 kg/s.

2.2. Experimental set-up

The experiment was performed during testing of well PT-5D in the period May–June 2001. Locally grown, 5 to 8-month-old mahogany (*Swietenia macrophylla* King) seedlings, and natural vegetation (mostly pioneer species) were used as test plants. The mahogany seedlings were distributed along the well pad radius (0–50 m) and in open areas beyond the pad (50–200 m), as permitted by the terrain, so as to catch both horizontal and vertical discharges. In addition to the mahogany seedlings, a strip of natural vegetation starting 50 m from the well was included in the physical damage observation and other analytical tests.

Unexposed seedlings cultivated at the nursery (about 1.5 km from the study site) and the natural vegetation at an unaffected pad (Pad A, about 1.2 km from the study site) served as control specimens. Catch basins were placed alongside the test seedlings in each station to collect the geothermal sprays for analysis of geothermal indicator ions such Cl, Na, B and Li.