Geophysical Surveys at Machu Picchu, Peru: Results for Landslide Hazard Investigations

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Abstract Geophysical methods are being used more frequently to assess slopes for landslide hazard potential, especially in areas where traditional methods such as trenching and drilling are either difficult to employ or not allowed. This paper presents the results of DC resistivity, electromagnetic (EM) and ground penetrating radar (GPR) surveys to map fractures and zones of weakness in crystalline bedrock at Machu Picchu, Peru. DC resistivity surveys were carried out along the upper 8 switchbacks of the Hiram Bingham road leading to the sanctuary as well as across the sanctuary. EM surveys were carried out along the upper 3 switchbacks and across the sanctuary. EM surveys were carried out at several other locations within the sanctuary but the data were not sufficient to allow detailed interpretations. GPR surveys were carried out over the main and lower plaza areas. Inversion of the resistivity data located several lower resistivity zones along the switchbacks. These zones were associated with water seeping out of the rock in ditches. The water is confined to the upper switchbacks which was consistent with the disappearance of lower resistivity zones in the lower switchbacks. EM results along the switchbacks, although more subtle to recognize, located several coincident zones of lower resistivity. The GPR data provided information on the unconsolidated sediment above bedrock and the bedrock topography within the plazas. There is presently no evidence on whether any of the mapped fractures have been active in the recent past.

Keywords Geophysics • Landslides • Peru • Electromagnetic • Resistivity

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16.1 Introduction

The UNESCO World Heritage Site of Machu Picchu, Peru, the royal estate of the Inca ruler Pachacuti in the 1400's, remained covered by vegetation and abandoned in the jungle for hundreds of years following the Spanish occupation of Peru (Wright and Zegarra 2000). Discovered early in the last century, the site is now host to some 1 million tourists per year. Recent shallow

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