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MULTIDISCIPLANRY STUDIES ON ALPINE ROCK GLACIERS

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Permafrost covers extensive areas of the Alps above ˜2500 m elevation. Significant portions of Alpine permafrost exist in the form of rock glaciers. These amalgamations of boulders, ice, water and air form on gently to moderately dipping mountain slopes. Subject to gravitational forces, they creep slowly downslope. The presence of ice within rock glaciers is a critical factor with respect to their kinematic and dynamic behavior. Ice influences the flow behavior and, more importantly, controls the mechanical stability. As a result of global warming, the ice contained in many rock glaciers is melting. This may result in catastrophic rock avalanches that are significant hazards in populated mountain areas. Assessing the stability of rock glaciers requires knowledge of their internal structures. Critical details include the distribution of ice, water and large voids, which can be delineated with high-resolution geophysical techniques. For designing field experiments it must be considered that rock glaciers are situated in high-mountain areas. Accessibility and pronounced topographic relief may create major logistical problems. Furthermore, the presence of crystalline rocks and ice causes the electrical resistivities to be extremely high, making it difficult to inject electrical currents into the ground using galvanic methods. Finally, the mixture of large boulders, ice, water and large voids results in highly heterogeneous structures. This is expected to generate pronounced scattering effects. For wavefield techniques, such as seismics or georadar, scattered energy may obscure reflected signals. We present results of two integrated studies performed on rock glaciers. Based on these results we propose a general template for investigating such structures. Thicknesses of rock glaciers can be determined efficiently using transient electromagnetic techniques, whereas their lateral dimensions can be resolved using DC resistivity tomography. If high resistivities preclude the application of DC resistivity tomography, refraction tomography pro-

vides a high-resolution, but more expensive, alternative. Under favorable conditions, cost-effective delineation of internal features of a rock glacier can be achieved using surface-based georadar methods. The most detailed data is supplied by crosshole georadar tomography.