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Internal structure, ice content, and dynamic behaviour of three Eastern Alpine rock glaciers

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The knowledge of internal structure and ice content is crucial for the understanding of the dynamics and evolution of rock glaciers. Observations in either boreholes or combinations of surface-geophysical methods such as GPR (ground penetrating radar), refraction seismology, DC-resistivity, and gravimetry are used to acquire this information. Between 2002 and 2004 GPR, seismic refraction, and gravimetry was applied on three active rock glaciers in the Eastern Alps. In addition, comprehensive geological, geomorphological, and hydrological studies were carried out. Further displacements were determined by the comparison of aerial photographs and GPS measurements. The three studied examples are Reichenkar (Stubai Alps), Ölgrube, and Kaiserberg (Ötztal Alps) rock glaciers. The source areas of these rock glaciers are situated at altitudes between 2700 and 2800 m a.s.l. The fronts of the tongues reach down to 2300 - 2600 m a.s.l. Their total areas vary between 0.22 - 0.27 km2, the maximum thickness is 30 - 50 m. During the last two decades the surface velocities of the Ölgrube and Reichenkar rock glaciers increased significantly, whereas the Kaiserberg rock glacier did not show this behaviour. Model of the internal structures (depth to ice-rich permafrost layer, unfrozen layer, bedrock) were derived by the combination of the results from GPR and seismic refraction. The unfrozen till between permafrost and bedrock was not directly observed. However, it was necessary to introduce this layer in order to match seismic and GPR data. Furthermore, till layers were observed in front of the rock glaciers. The ice content of the permafrost layers was derived from the additional gravimetric data. On the basis of the structural models and the ice contents creep velocities were calculated by an extension of Glen's flow law for pure ice. Calculated

creep velocities agree with observed ones within the uncertainties of the rheological model. Finally, processes are discussed which might explain the variations of creep velocities observed at Ölgrube and Kaiserberg rock glaciers.