Inferring denudation rates and rock glacier ages from sediment budget models (Andes of Central Chile)

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A set of three simple model equations describing rock glacier sediment budgets is used to estimate denudation rates d (in the sense of vertical lowering rates), rock glacier advance rates v and rock glacier ages a of a random sample of $n = 30$ intact singular talus rock glaciers in the semiarid Andes of Santiago de Chile ($4400\,\mathrm{km}^2$ above $3000\,\mathrm{m}$ a. s. l.; 33–$34.5°$ S) based on morphometric data.

Model equations describe the sediment budget of rock glacier talus sheds, the debris supply in the rooting zone, and the growth of rock glaciers in length; each two of these three equations form models of d, v and a. The debris-transport system of rock glacier talus sheds is assumed to be a closed system. Based on geomorphological evidence, the model constraint is imposed that 'most' rock glaciers (assumption: three quartiles) are not older than $10\,\mathrm{ka}$. The models yield then consistent combinations of the system variables.

Estimated average denudation rates for the whole sample are of 0.75–$1\,\mathrm{cm/a}$, with approximate first and third quartiles of 0.6 and $1.5\,\mathrm{mm/a}$. Given the mentioned assumption, rock glaciers were estimated to be on average 5–$6\,\mathrm{ka}$ old (lower quartile: c. $3\,\mathrm{ka}$), and to have advanced on average at about 6–$8\,\mathrm{cm/a}$, with sample quartiles of c. 4 and $10\,\mathrm{cm/a}$. The alternative models yield very similar results.