Quaternary Newsletter
Book Review
QRA Quaternary Research Association

179 EGLISAU (SHEET 1051) AND 180 REICHENAU (SHEET 1195) 1:25,000 LANDESGEOLOGIE (GEOLOGISCHER ATLAS DER SCHWEIZ, ATLAS GÉOLOGIQUE DE LA SUISSE, ATLANTE GEOLOGICO DELLA SVIZZERA) MEMOIRS, GEOLOGICAL MAPS AND PLATES

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Both these 1:25,000 geological maps covering distinctly different parts of the high Rhine catchment are worthy of note. The memoirs in German have introductory summaries in French, Italian and English. Text from the freely downloadable pdf versions can be loosely translated; if required technical vocabulary can be checked against visual searches to try and yield familiar diagrams or put them into a context. Furthermore, the Lithostratigraphic Lexicon of Switzerland provides entries for all their mapped units in up to four languages, including some useful English terminology. The swisstopo online

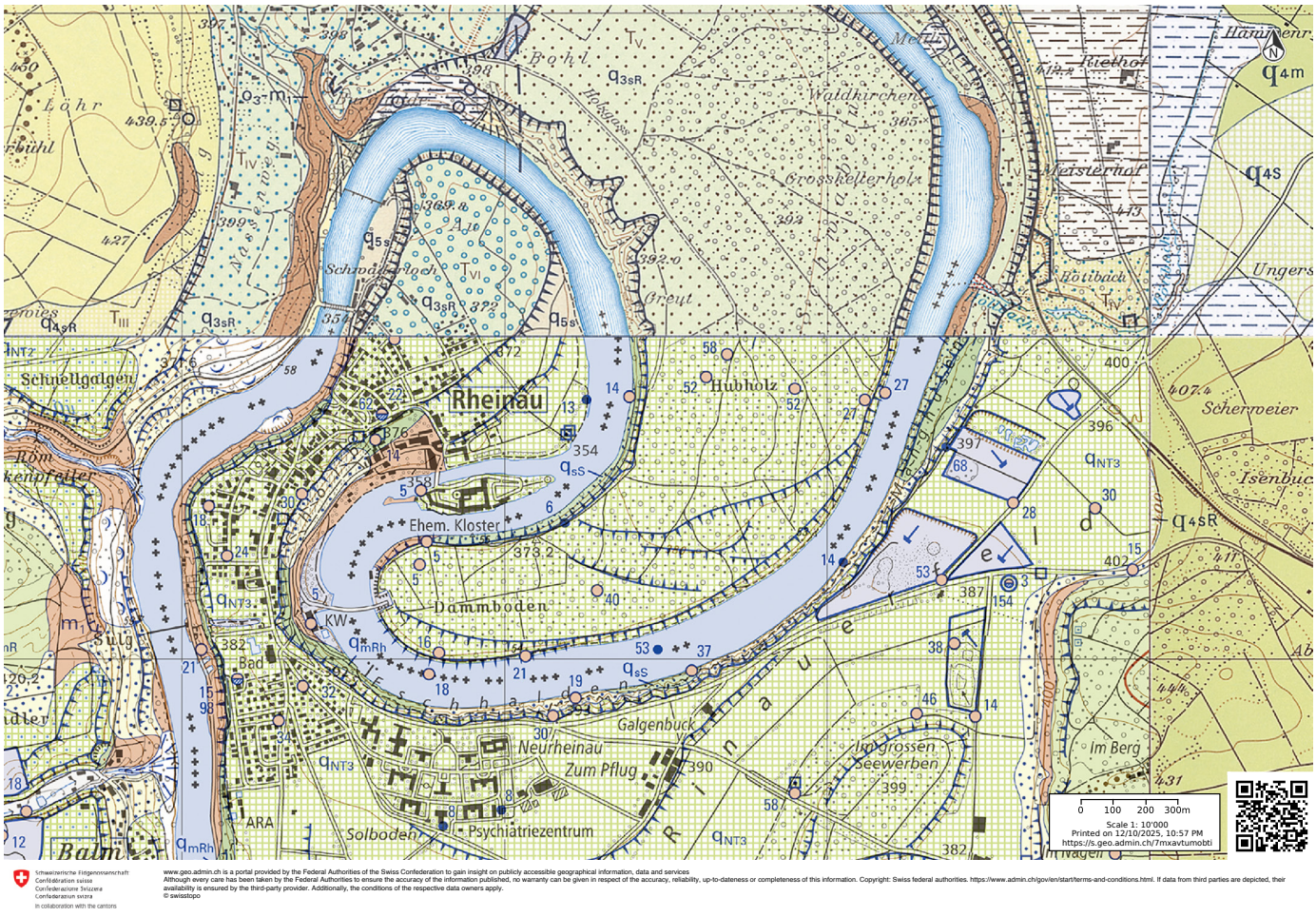


Figure 1: Updated 1:25,000 geological mapping around Rheinau including newly published Eglisau (1051) sheet alongside: Northern portion, Sheet 74 Neunkirch (1031) published in 1981; NE extract, Sheet 38 Diessenhofen (1032) 1961; SE extract, Sheet 52 Andelfingen (1052) 1967, compare with (Nowell 2021, Fig. 2). Mainly showing extent of river terraces, with glacial moraines and tills on higher ground, plus peat bogs near NE corner, with Miocene bedrock in darker browns. Copyright © swisstopo, All rights reserved

data viewer (Nowell, 2021) allows these beautifully drafted geological maps to be enlarged to around 1:10,000, without loss of cartographic integrity; a simple click identifies individual units (Fig 1). The geological viewer incorporates other districts with its GeoCover – Vector Dataset layer, until the remaining sheets are completed, while updating older sheets with more detailed geological boundaries. However, no links are provided about the basis upon which these revisions have been made. So far 179 maps have been published (176 is pending), out of 220 maps, combining some adjacent sheets covering border areas into single editions.

Each wallet with its own photograph includes a 210 by 148 mm memoir with a cover photograph, map and plates in three pockets. On their paper covers, the elegantly folded maps have a simplified coloured geological map draped over synthetic topography, extending slightly beyond their neatly drawn sheet lines, including lakes, rivers, significant locations and peaks. The margins include detailed keys, alongside definitions for a wide range of local geological symbols and lines. Standard sheets cover 17½ km E-W by 12 km N-S, using the topographic series. They also have accession numbers starting with the publication of the first geological map in 1930. Both sets of sheet numbers are shown on the index map printed on the back cover. In areas obscured by superficial deposits the underlying bedrock geology is not shown, apart

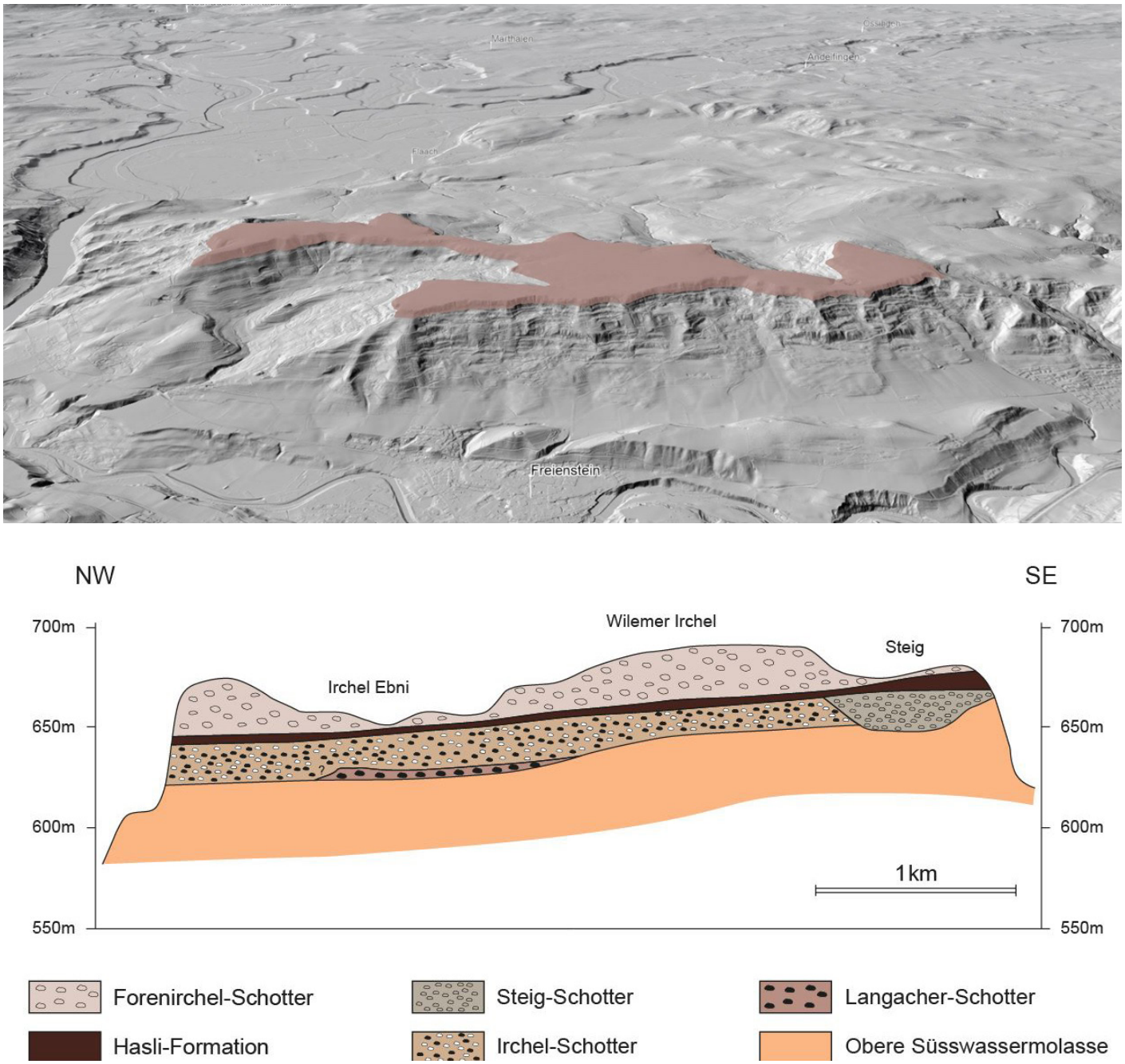


Figure 2: a) Distribution of Upper Deckenschotter blanketing Irchel Plateau up to 40 m thick. b) Section through these varied deposits resting upon Upper Freshwater Molasse bedrock in orange. Copyright © swisstopo, All rights reserved

from projecting significant faults beneath them, which might influence the overlying geomorphology. Various colour coded series of distinctive dots and dashes mark some superficial deposits, along with relatively easy to comprehend symbols. Borehole depths are noted, and those reaching the bedrock are indicated with a coloured circle for the underlying formation. Neatly annotated features include: erratics; dolines; surface sinks without surface drainage; former glacial and river channels; edges of erosional features, terraces and landslips; quarries and peat cuttings.

The Eglisau sheet is just downstream of the Rheinfall which has a 23 m drop, to the south of the town of Schaffhausen. This meltwater channel linked the Bodensee – Lake Constance Rhine glacier formed towards the end of the Saalian glacial stage around 130 ka inferred by OSL dating of the Schaffhausen gravel. About a third is in Germany to the west and north of the river Rhine, on the margins of the southern Black Forest escarpment. To the south of the Rhine the terrain is dominated by Quaternary glacial advances and fluvial erosion of Molasse bedrock just beyond the margins of successive Alpine ice sheets. The district ranges in elevation from 695 m on the Irchel plateau in the far southeast to 332 m on the Rhine flowing westwards out of the district. The Miocene bedrock has very limited outcrops, and heavy mineral analysis was applied to help separate out and map successive wedges of Molasse sequences with 3D modelling of these boundaries, including data points beyond the margins of this sheet.

Following a hiatus of around 12 Ma, an extraordinarily varied and well documented succession of Quaternary material survived later episodes of erosion within the district. There is a welcome summary of the extent of glaciation during 16 cold stages, coupled with fewer named interglacials. The fact the Last Glacial Maximum – LGM is not the most extensive suggests this ice sheet was stuck within the 'moat' resulting from the erosional uplift of the Alpine foreland. The oldest mapped deposits are the Upper and Lower Deckenschotter, preserved as complex sequences of plateau formations left high above current fluvial drainage levels (Fig. 2). They are not only glaciofluvial gravels as its name implies, but include soil formations and flood deposits associated with intervening warm intervals. The stratigraphically younger Lower Deckenschotter is separated from the stratigraphically older Upper Deckenschotter by a period of erosion and downcutting of the drainage network. Their overall thickness is not clearly stated, but the sequence of higher units are 40 to 50 m thick. Within this, the Hasli-Formation consists of older Early Pleistocene interglacial sediments a few metres thick

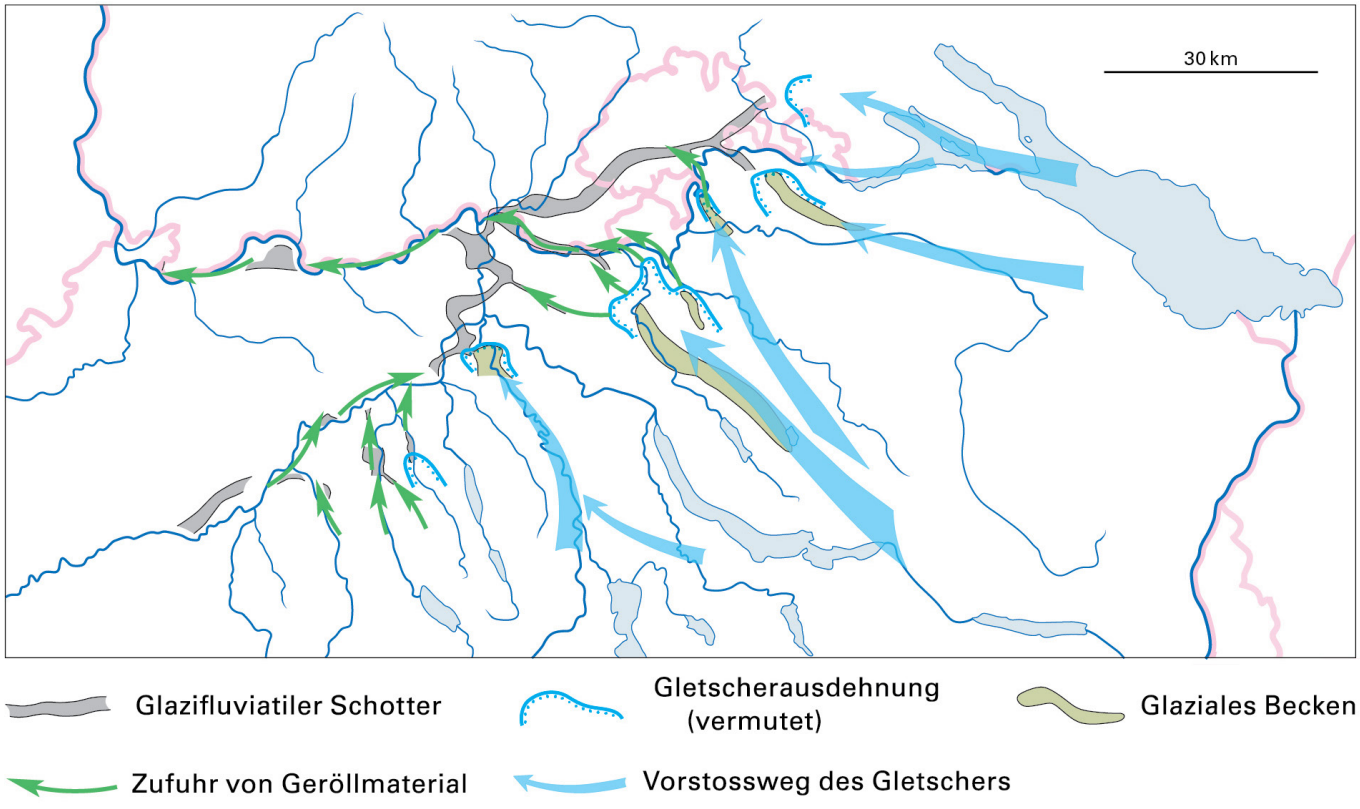


Figure 3: One of a series of glacial drainage maps across central northern Switzerland, in this case showing conditions and glacier extent during Middle Pleistocene Habsburg Glacial. Glaciofluvial gravels in grey, green arrows indicate direction of gravel supplies, blue lines with ticks along inside suspected glacial extent, blue arrows direction of ice flows, glacial basins light olive green. Copyright © swisstopo, All rights reserved

varying between seven detailed stratigraphic logs, coupled with photographs of methodically presented temporary sections through three sequences.

Up to 65 m of lower cover gravels were deposited following 80 to 100 m of downcutting across northern Switzerland. They are subdivided by middle gravels rich in dolomite clasts, indicative of Töss valley drainage linked to the Walensee arm of the Rhine glacial dome, without any indication of intervening warm intervals occurring between each distinct depositional phase. Clearly these earlier ice flows were already on a cusp, as during the LGM the Grisons glacier bifurcated around Sargans, where the river Seez without its headwaters being deflected by its own rubble cone, could have captured the Alpine Rhine (Nowell, 2022). Nearly half of the text is devoted to the superficial deposits, illustrated by a series of neatly drawn palaeo drainage and ice flow maps, including the approximate positions of ice fronts and glaciofluvial gravels (Graf, 2024; Fig. 3.). Tills in between gravels and other deposits cover significant portions of the district and are also described.

The Middle Pleistocene terraces can be divided into several ice ages, in places leaving behind exceptionally thick gravel deposits. Coupled with Upper Pleistocene sequences characterized by over deepened valleys within glacial fluvial deposits, which rise downstream indicating they were not formed by freely flowing water. These troughs are detailed with a couple of beautifully drawn figures (Fig. 4) and three cross sections on a separate plate, backed up by a contoured 1:50,000 map of the bedrock surface based on borehole and seismic data. All of this is illustrated by excellent well captioned photographs coupled with the use of precise grid references within the text itself. Late glacial and Holocene deposits include landslides; rubble, loamy and clay slope debris; tufa, stream debris; anthropogenic changes, with gravel pits in purple. While a clear distinction is made with uncalibrated radiocarbon dates and real time, BP is used erroneously, and the Younger Dryas ended 11,700 years BP at the base of the Greenlandian Stage according to the International Commission on Stratigraphy. Hydrology included notes on abstraction from the gravels on either side of the border and protection zones around these points, plus bedrock sources. As usual there is an extensive bibliography.

The Reichenau district includes most of the city of Chur and Alpine Rhine, westwards towards the Vorderrhein and Hinterrhein confluence forming its headwaters. The deeply incised valleys range in height from 545 m where the Rhine exits the sheet, to Crap Mats 2,946 m and Fulhorn 2,528 m in the opposite

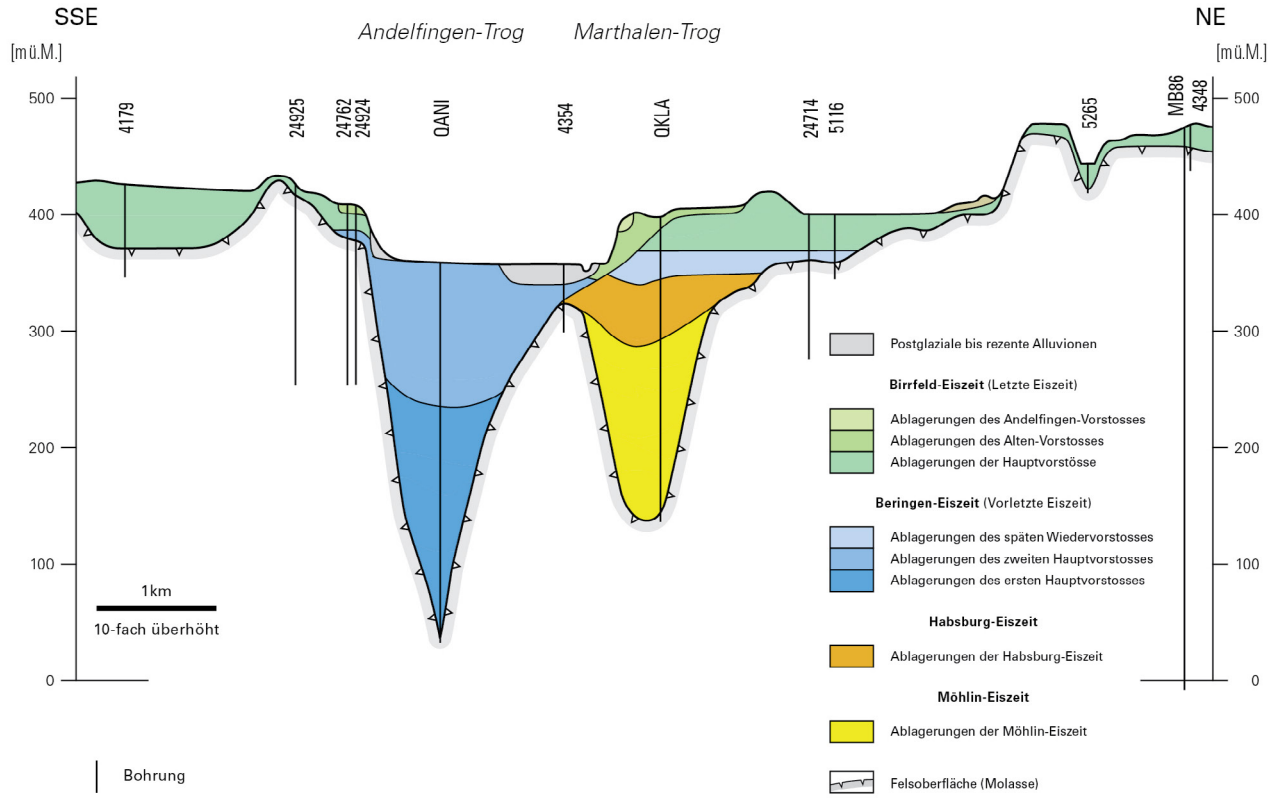


Figure 4: Cross section across lower Thur valley, within Andelfingen sheet 1052 to east of district based on seismic instigations tied to boreholes. Möhlin glaciation yellow, Habsburg Glacial deposits orange, Beringen Glacial blue shades, last Birrfeld Glacial greens, postglacial and recent alluvium grey. Ten times vertical exaggeration. Copyright © swisstopo, All rights reserved

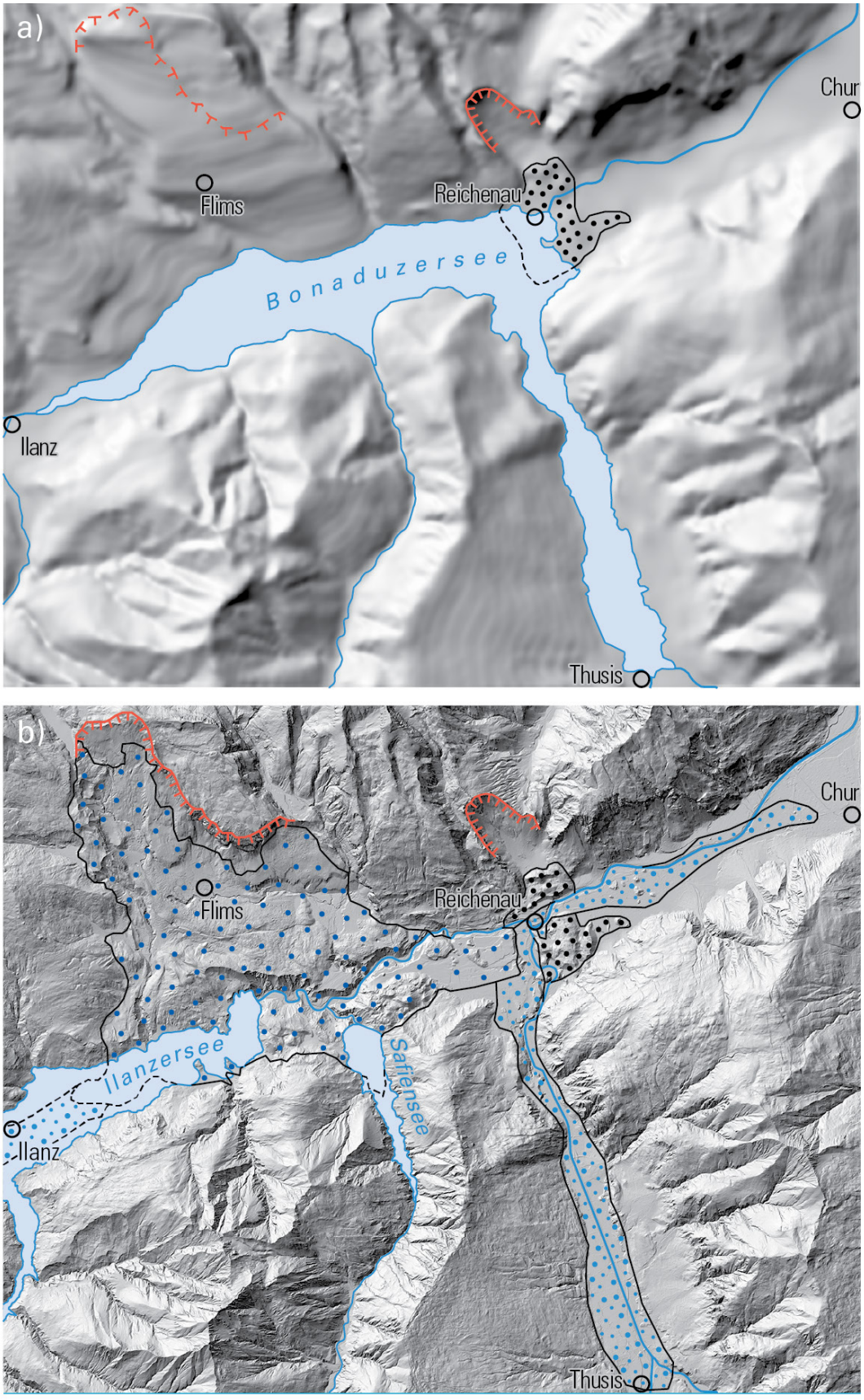


Figure 5: a) Reconstructed digital terrain model after collapse of the Tamins landslide resulting in Lake Bonaduz. b) Situation after collapse of Flims landslide, including temporary lakes - Ilanz & Safien. Red lines edges of landslide detachments, spaced ticks future detachment, blue stipple liquefied lake & valley fill – Bonaduz Formation, blue dots Flims landslide debris, black dots Tamins landslide debris, extent of past lakes light blue. Copyright © swisstopo, All rights reserved



Figure 6: Aerial photograph of Reichenau breach between Cartschitscha and Ils Aults annotated in white, either side of Alpine Rhine, flowing eastwards towards Chur. Copyright © swisstopo, All rights reserved

corner. Earlier superficial deposits were stripped away or buried by Late Pleistocene glaciation, with up to 400 m of material filling the main valley beneath the flood plain. All but the highest peaks were covered during the LGM. The Kunkels Formation consisting of slope parallel limestone debris is overlaid by glacial moraines south of the Kunkels pass and is exposed on the slopes to its north within a side valley (Löpfe et al. 2024). The Vättis sheet 178 covers this district, with a km wide eastwards extension including the slopes down towards the river Rhine. The highest erratics are found at 2,100 m above sea level, and many slopes are blanketed by extensive glacial moraines. Local moraines were deposited by smaller glaciers advancing out of side valleys towards the end of the Pleistocene.

The Holocene deposits are of particular note, especially those associated with the Tamins, 9,420 ± 880 yr, and Flims, 8,900 ± 700 yr, landslides, which detached from the northern flanks of the valleys, before sliding across them with much of the debris coming to rest along the foot of the opposite slopes. These deposits are colour coded with dots signifying the composition of blocks caught up within them. Some are so substantial, they were originally mistaken for disjointed portions of bedrock. The Flims rockslide hit Lake Bonaduz, which formed after the first mega slide blocked the Vorderrhein and Hinterrhein confluence (Fig. 5). This impact produced a tsunami which washed earlier material out, to leave a layer of distinctive deposits. Above this, the Bonaduz-Formation settled out of the lake as a liquified suspension of silt, sand and gravel

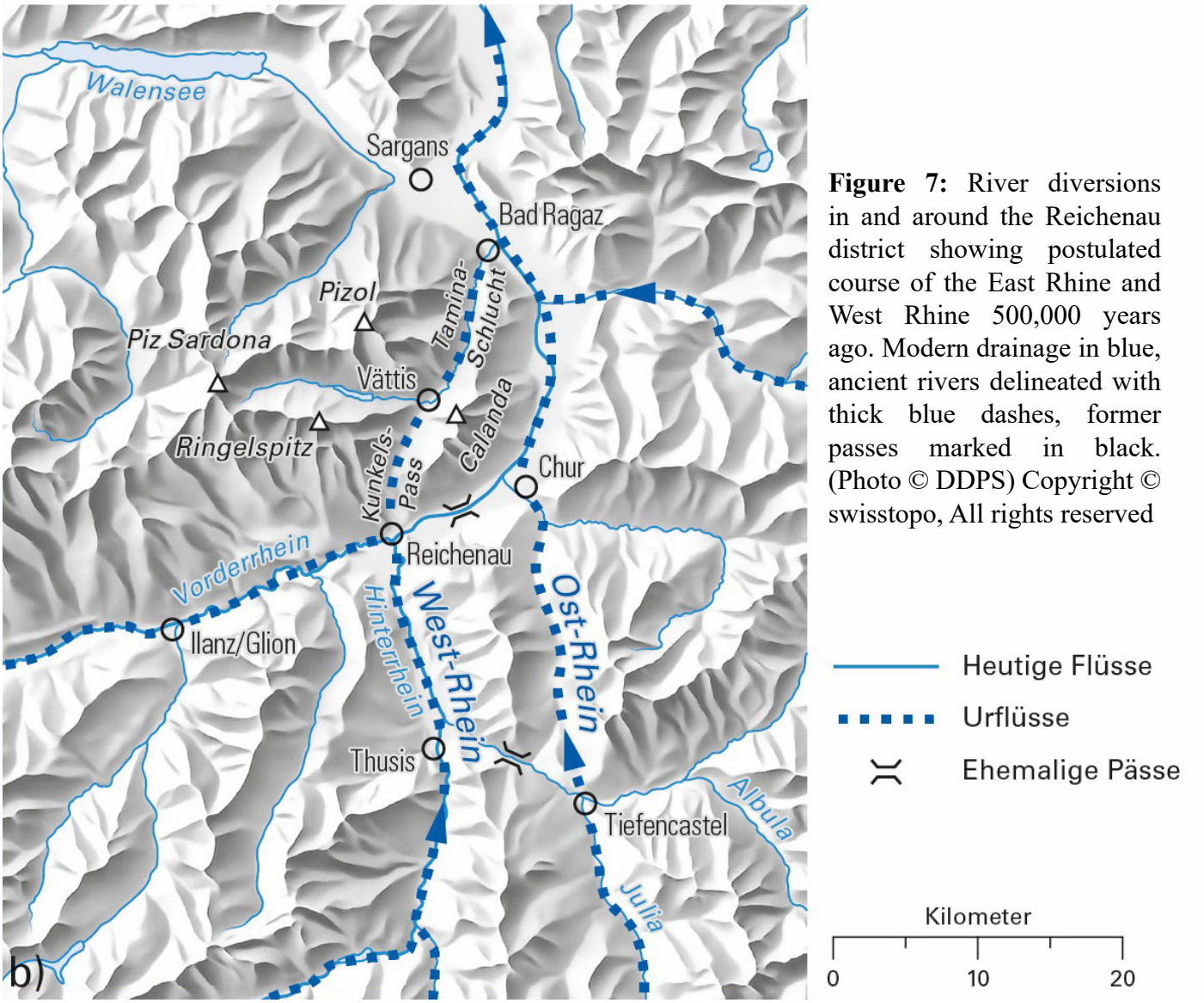


Figure 7: River diversions in and around the Reichenau district showing postulated course of the East Rhine and West Rhine 500,000 years ago. Modern drainage in blue, ancient rivers delineated with thick blue dashes, former passes marked in black. (Photo © DDPS) Copyright © swisstopo, All rights reserved

over 175 m thick in one borehole beneath the town. Later, a third Bargis collapse from the SW flank of Teschep Sut consists of blocks of Tros limestone, plus a ~2½ ha mega block, upon which Belmont castle was built. However, it does not appear the context of these slides was considered in terms of post glacial instability: both in relation to the melting of the glacier which propped up the flanks of the mountainside, and permafrost which might have temporarily held the bedrock together.

The section also briefly outlines other superficial deposits including: older & recent alluvium; scree; solifluction material; disintegrated slides; debris cones; alluvial fans; tufa; swamp & peat; made ground. All of this is beautifully illustrated with numerous photos coupled with a few digital elevation models of geomorphological features including the Ransun alluvium above the Vorderrhein, showing the former stream courses across this tilted pain, and close up of the Tamins landslide mass around Ils Aults, also seen in an aerial view of Chur down the Rhine valley (Fig. 6). It also notes the impact rock falls from crags high above villages, plus in 1939 an extreme case when 15 million m^3 of debris destroyed a children's home and killed 18 people. The map shows a series of linear and discrete geomorphological features, including debris channels, former stream beds and glacial channels, slope breaks and edges including those high above narrow valleys above modern rivers, various erratics, and even attributes like whirlpools and glacial potholes.

A significant portion of the text is devoted to the districts landscape evolution over the last 500 ka, based on extrapolating uplift rates over the last 3 Ma underpinned by particularly young appetite fission track ages. On this basis, the east and west Rhine valleys must have been at least 750 m higher around Reichenou allowing drainage over Kunkels pass via Vattis (Fig. 7). A seismic section near Chur images the bedrock around sea level due to glacial over deepening,

filled with glaciofluvial and glaciolacustrine deposits, which, around 410 m above sea level, are capped by Rhine gravels. The northern edge along which the Tamins landslide detached, is neatly picked out by a series of truncated drainage channels on slopes above it in blue on a digital terrain model. The text contradicts the seismic section, as the Bonaduz formation can't be more than ~160 m thick and not 230 m as stated. Overall, this section goes into much more detail about landscapes associated with these larger scale events. Useful information is contained within the brief passages on hydrology, minerals in relation to sand and gravel extraction, and finally archaeology: there are signs of Paleolithic habitation by hunter gathers around the end of the Pleistocene and later Neolithic remains include coarse ceramic storage vessels by around 5.5 to 5.0 ka.

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