# Provenance tracing and differential erosion in the headwaters of the Rhein River

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## Introduction

A river channel receives sediment input from hillslopes and the channel itself. In the headwaters of the Rhein River, significant control of hillslopes is evident. Two coalesced fans appearing at Disentis and Sedrun exemplify this and erosional recycling of the fan material can influence the sedimentary budget of the Rhein River. It is the scope of this work to explore this further. Accordingly, the goals are:

- To calculate differential erosion in the sub-catchments
- To trace the sediment provenance based on geochemical fingerprints
- To develop a sedimentary budget of the entire catchment and to calculate the contribution of the two coalesced fans
- To reconstruct the depositional history of the fans

## Methods

Detailed geomorphological mapping

LA-ICP-MS for major oxides

10Be measurements for stream + fan sediments

Sedimentary budget of the catchment

## Geological Setting

The Rhein River originates at Tomasee located at 2344m above msl in the Canton of Graubünden. The main channel and its many headwater tributaries drain the crystalline lithologies of the Gotthard Massif, the Aar Massif and the Tavetsch Massif along with an extensive quaternary cover.

9 sampling locations were selected including the two coalesced fans for further analysis.

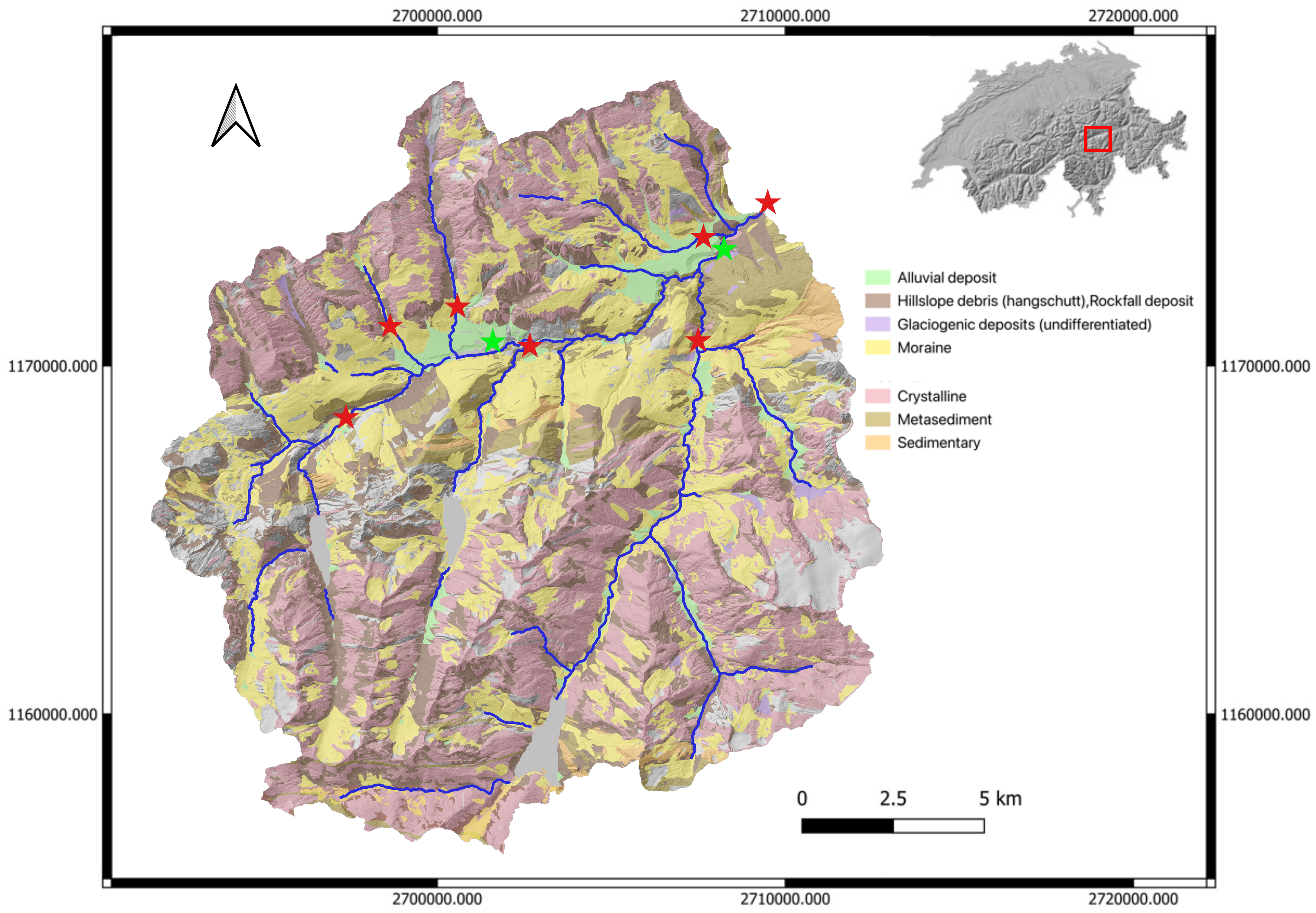


**Figure 1.** A geomorphological map for the headwaters of the Rhein River.

## Results

1. The geomorphological map (Fig.1) displays the dominant crystalline bedrock lithologies and the cover of non-consolidated material on the hillslopes
2. LA-ICP-MS data of major oxides can be interpreted for geochemical fingerprints for different sub-catchments.
3. Samples for $^{10}$Be processing are in their last stages before complete for AMS measurements.

| | SiO2 | Al2O3 | Fe2O3 | MnO | MgO | CaO | Na2O | K2O | TiO2 | P2O5 |
|---|---|---|---|---|---|---|---|---|---|---|
| | wt % | wt % | wt % | wt % | wt % | wt % | wt % | wt % | wt % | wt % |
| VDR_1 | 69.45 | 12.34 | 4.97 | 0.092 | 1.6 | 2.06 | 2.87 | 2 | 0.65 | 0.44 |
| VDR_2 | 66.33 | 17.09 | 3.13 | 0.048 | 1.26 | 1.84 | 4.71 | 3.88 | 0.36 | 0.15 |
| VDR_3 | 73.3 | 13.44 | 2.91 | 0.074 | 0.79 | 1.4 | 3.92 | 3.37 | 0.354 | 0.12 |
| VDR_4 | 66.75 | 14.36 | 5.14 | 0.093 | 2.44 | 2.57 | 3.02 | 2.84 | 0.661 | 0.32 |
| VDR_5 | 67.05 | 12.82 | 5.94 | 0.079 | 1.72 | 1.96 | 3.12 | 2.25 | 0.647 | 0.44 |
| VDR_6 | 62.61 | 16.39 | 6.19 | 0.1 | 1.75 | 1.81 | 0.92 | 4.33 | 0.86 | 0.32 |
| VDR_7 | 71.56 | 12.43 | 3.31 | 0.052 | 1.16 | 2.66 | 3.67 | 2.36 | 0.574 | 0.28 |
| VDR_8 | 78.35 | 10.12 | 2.23 | 0.036 | 0.52 | 1.44 | 2.69 | 2.78 | 0.315 | 0.3 |
| VDR_9 | 68.29 | 12.83 | 5.51 | 0.084 | 1.61 | 3.05 | 2.9 | 2.26 | 0.718 | 0.61 |

**Table 1.** LA-ICP-MS data for major oxides

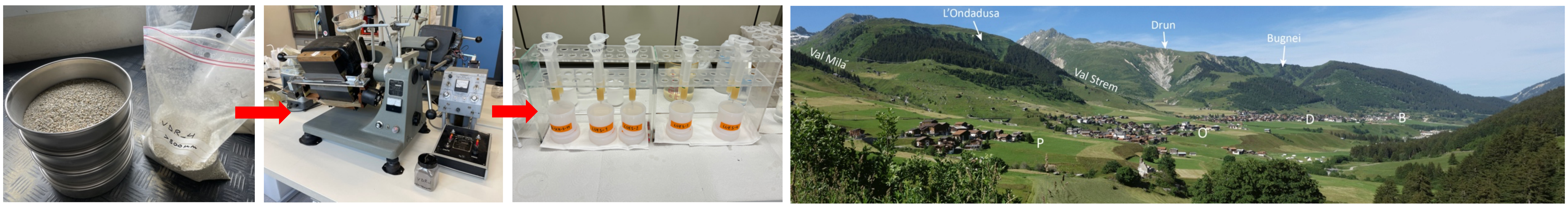


**Figure 2.** (A) Sieving for 250-400 µm size sediment (B) magnetic separation (C) Anion Column during chemical separation (D) Coalesced fan at Sedrun (Dieleman et al., 2018)

## Conclusion

The geomorphological map shows the dominance of moraine material (strong glaciogenic controls) and alluvial deposits. These reservoirs are coupled with the stream channels. Recycling of the accumulated fans was seen with the Rhein River channel where the stream is incising into the terraces at Sedrun and Disentis.

## Outlook

- Target pressing of the samples as final step towards AMS measurements.
- Transfer $^{10}$Be results to Basinga GIS toolbox to calculate basin average denudation rates.
- Plot a mixing model using the LA-ICP-MS data to trace the provenance of the sediments and assess different morphogenetic domains.

**Acknowledgements**

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**References:**

Dieleman, C., Ivy-Ochs, S., Hippe, K., Kronig, O., Kober, F., & Christl, M. (2018). Reconsidering the origin of the Sedrun fans (Graubünden, Switzerland). *E&G Quaternary Science Journal*, *67*(1), 17-23.

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