Swiss Core Curation and Storage Facility (SWICCS)

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General rationale

Across the Swiss geoscience community, and imposed by emerging international obligations and standards for **Archiving** (data and specimen), **FAIR data principles (**easily **F**indable, **A**ccessible, **I**nteroperable and **R**eusable) and **Reproducibility**, there is a nationwide recognized and urgent need for a professional and sustained **Data and Sediment Core Curation** facility with managed data and sample storage and archiving. State-of-the-art sample storage is not only a precondition for us to conduct our research, it is at foremost an obligation and compliance towards our national and international funding agencies. Data, core and sample storage represents a fundamental prerequisite with which verification and reproducibility of geoscientific research results is warranted. Analysis of physical sample materials lies at the heart of many key disciplines in the domain of the geo- but also the bio- and archeological sciences and helps to elucidate on processes that shaped the face of the Earth and its response to modifications made by humans. Analytical methodology is constantly undergoing refinement with the advert that novel methods applied to the various sample materials allow novel insights into and/or refinements of Earth science theory. Collecting natural samples is, however, often very time consuming and costly and, in some cases, even not easily achievable due to restricted access to sampling location and technical challenges involved with collecting certain sample materials. The latter is particularly true for the cost-intensive, logistical and technical challenging retrieval of drilling and coring materials, which can easily require funding on the order of several million CHF per project and multiple years of time for project preparation. As such, physical storage and appropriate curation of drilling and coring samples originating from those materials is crucial to maintain scientific progress and to conserve heritage across generations of researchers.

Currently, scientists at Swiss institutions are lacking adequate facilities that can accommodate and service complex and evolving sampling needs and infrastructure for rapid and comprehensive characterization of sedimentary, igneous, and metamorphic rock drill cores or other valuable and delicate samples (e.g. core-based biologic/microbial/genetic samples but also fossil wood logs). Moreover, the new data management policy set out by the SNSF and other research funding agencies requires long term storage of samples along with metadata and data emerging from sample/core analyses in the mandatory data management plan (DMP). Similarly, leading research journals request authors to comply with the FAIR data principles, which includes strict guidelines on data archiving and best practice recommendations for sample archiving. Yet, to date Swiss institutions lack facilities suitable for long-term sample/core storage, most importantly centralized facilities and infrastructures serving these purposes are non-existent. In most Swiss led projects, metadata for samples/cores are currently not systematically stored. Additionally, data sets not used for publication are typically not systematically stored in a dedicated database, and sediment cores are often discarded after the termination of projects because of shortage of storage space. Due to the lack of a centralized Swiss facility and peculiarities related to chair successions at the universities, precious decadal-long fossil sample collections are at risk of elimination. As such the Swiss geoscience community recognizes the urgent need to establish a core storage and curation infrastructure for professional core and metadata storage and curation with facilities allowing for standardized initial core documentation and sub-sampling to perform state-of-the-art scientific projects competitive at the international scale.

Such an infrastructure will allow Swiss scientists to be part of a truly global community in pursuit of better understanding Earth processes through scientific drilling and coring. Processes studied by Swiss scientists are diverse and cover: i) active faulting and earthquake generation, ii) global cycles affecting climate and environmental change, iii) heat and mass transport, iv) the deep hidden biosphere, v) cataclysmic events, vi) natural resources and vii) human impact on the environment. Over the past years, researchers from Swiss institutions have actively been involved in scientific drilling and coring initiatives by engaging in various IODP (International Ocean Discovery Program), ICDP (International Continental Scientific Drilling Program), ERC, and SNF funded projects. Results of recent scientific drilling and coring campaigns with key-proponents from Swiss institutions have been pivotal in advancing our knowledge of mid-ocean ridge processes, hydrothermal activity, decoding the deep geobiosphere (such as IODP drilling at the Atlantis Massif and the ICDP Oman Drilling Project) or the reconstruction of past climates and environment through head-line making lake-drilling projects (e.g., Lago Petén Itzá, Lago Potrok Aike, Lake Van, Lake Ohrid, Lake Towuti). The discovery of annually laminated sediments in Switzerland (e.g. Soppensee, Moossee, Burgäschisee) and buried logs allowed breakthroughs in Late Glacial and Holocene geochronology. While central core storage facilities exist for IODP cores and less developed solutions also exist for ICDP cores, dedicated storage for Swiss led ERC and SNF projects is lacking completely nor are the requirements for drill-core storage and curation lined out. Having dedicated core/sample storage and curation facilities will not only allow Swiss scientist to properly store the material for future research projects, future generations of researchers and make the material accessible, taking into account open-access and FAIR principles, but would also attract the interest of international researchers giving them access to highly valuable scientific material. The envisaged facility will furthermore function as a hub for interdisciplinary research projects involving the bioscience (e.g. paleoecology, paleophysiology, evolutionary biology, aDNA) archeology (e.g. geoarcheology, bioarcheology, dendrochonology) communities working on Earth materials. In summary, such a core curation and storage facility will play a pivotal role in strengthening international collaborations and partnerships through Swiss leadership allowing to steer interdisciplinary and multidisciplinary research at the forefront of the geosciences.

Highly valuable core sections and samples are an important heritage for follow-up research and education. Archiving this information is of utmost importance and providing the necessary backbone for launching new drilling initiatives. Having one centralized national core storage and curation facility will serve as a competence center, laying out the base for future drilling proposals. Core and sample storage at the Swiss level, will also facilitate and centralize data of high societal relevance. The accelerated Swiss geothermal energy exploration and the active search for radioactive waste disposal sites, results in an increasing archive of newly acquired boreholes and core data. Centralizing the access to those increasing number of existing core sections and borehole data, will facilitate discussions at national level regarding the management of geothermal energy resources, water exploitation and radioactive waste disposal. Also within the light of accelerated climate change available core data needs to be centralized as they provide crucial information on the subsurface, i.e. archives of past climate and environmental change necessary to paint more concrete narratives for how a future climate may manifest itself globally but also locally in Switzerland (cfr. extreme droughts, waning of the cryosphere, pertained access to water resources, changes in the geobio-ecosystems, tipping points in the climate system). Centralizing this hands-on core information will provide the data and tools to the government to develop future climate strategies.

Industry & federal offices

The proposed facility would also nicely accomplish recent initiatives by Federal Agencies for similar storage and curation purposes while also accommodating relationships to industry. In

fact, Swisstopo is planning to install a national core repository for non-refrigerated hard-rock core sections at the Mont Terri underground laboratory. This core repository will primarily receive drill cores from exploration boreholes sampled across Switzerland by the federal agencies but will also eventually host drill cores from nuclear waste disposal- (NAGRA), geothermal-, groundwater-, carbon capture and storage- reconnaissance boreholes as well as seismologic drillholes and observatories. In light of these current developments, Swisstopo already signaled interest to team up for an open-access and multifunctional core repository platform capable of providing storage and curation capacities for any type of hard- and soft-rock cores. The facilities proposed by the Swiss geoscience community would include capacity for refrigerated core storage while also being equipped with facilities for core opening and in-situ analysis (scanning). This would thus complement the federal core repository initiative without duplicating storage capacities in Switzerland while benefiting also the federal offices and industry thereby fostering industry-academia partnerships.

Education

National core storage and curation facilities are ideal hubs for training graduate students and early career researchers in key skills related to initial core documentation and state-of-the-art core-scanning technologies. Such training can be organized on a per project base but also through courses offered by the facility staff to students and early career researchers from Swiss universities. Training could furthermore be extended towards international participants through dedicated summer schools, thereby also increasing the visibility of the Swiss geoscience landscape, while fostering exchange between international and Swiss students and early career researchers already at the beginning of their academic and industry careers. Core sections are also very demonstrative objects to visualize how past gradual but also catastrophic changes in the Earth System are recorded in natural archives. Public outreach events hosted at the facilities can help at providing insights on how Earth scientists are using natural archives to study the factors determining Earth's habitability.

Proposed Swiss Core Curation and Storage facility (SWICCS)

The proposed Swiss Core Curation and Storage Facility requires sufficient capacity to store core sections and samples produced in the course of one generation (e.g., ~50 years) while being located in a central and easily accessible location in Switzerland. From an infrastructure perspective such a repository should at least feature the following:

1. Capacity for several kilometers of refrigerated (4°C ± 1°C) cores;
2. Capacity for several kilometers of non-refrigerated hardrock cores and fossil logs. A hardrock-core repository already exists at Swisstopo (only for temporary storage), and Swisstopo is planning to expand this storage facility by moving it to the Mont Terri underground laboratory. Swisstopo is interested to cooperate within this initiative;
3. Capacity for storing curated collections of core-based biologic/microbial/genetic samples
4. Freezer room capacity (-20°C ± 1°C) for the long-term storage of frozen cores
5. Freezer capacity (-80°C ± 1°C) for high-priority sediment sample storage for nucleic-acid (DNA etc.) or other temperature-sensitive analyses;
6. Core cutting, sampling, and core description facilities (including sufficient space for educational training and outreach activities);
7. Core-scanning facilities: whole and split core multisensor core logger, whole and splitcore imaging (CT, linescan, hyperspectral), scanning XRF (elemental geochemistry);
8. A dedicated clean sampling lab for microbial DNA and sedimentary ancient DNA sampling;
9. Database for core/sample meta- and analytical data
10. Mobile laboratory containers with infrastructure, which can be deployed on land and at sea (e.g., mobile core-logging laboratory, mobile geomicrobiological laboratory, etc.)

11. Staff: such centers require qualified and long-term employed professional personnel (curators, IT specialists and scientific management, etc.).

Given the required refrigerated storage capacity sufficient for ~50 km of core (based on current figures and projected over a 50 year period; here a link to the similar scale LacCore LDEO infrastructures in the US, as already realized professional examples: http://lrc.geo.umn.edu/laccore/facilities.html; https://www.ldeo.columbia.edu/core-repository/facilities) as well as the need for freeze-room storage of frozen materials (permafrost, freeze cores, DNA samples etc.) the repository will require space on the order of 6000 m^2, a figure that is very similar to a cold storage warehouse. As such the facility could either be developed from an existing and repurposed commercial cold storage warehouse or designed from scratch using existing cold storage designs with an estimated pricing in the order of >20 M CHF. Further costs incur for special laboratory finishes and equipment purchases and likely amount to ~5 M CHF. Annual costs from energy consumption, maintenance of the facility and equipment, consumables, as well as costs incurring for staff for such a facility are estimated at 1 M CHF/year. The total amount necessary to develop the infrastructure and to maintain it over the 2025 - 2028 funding period will therefore amount to >30 M CHF.