Central and Eastern Siberian Lake Hydrochemistry

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR-
UND MEERESFORSCHUNG

B. Heim, M. Wieczorek, K. Stoof-Leichsenring, B. Biskaborn, A. Morgenstern, P. Overduin,
A. Eulenburg, I. Baisheva, S. Kruse, U. Herzschuh
Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung AWI, Germany

K. Elger
GFZ German Research Centre for
Geosciences, Potsdam, Germany

I. Baisheva, E.S. Zakharov, L.A. Pestryakova,
Institute of Natural Sciences, North-Eastern Federal
University, Yakutsk, Russia

I Motivation

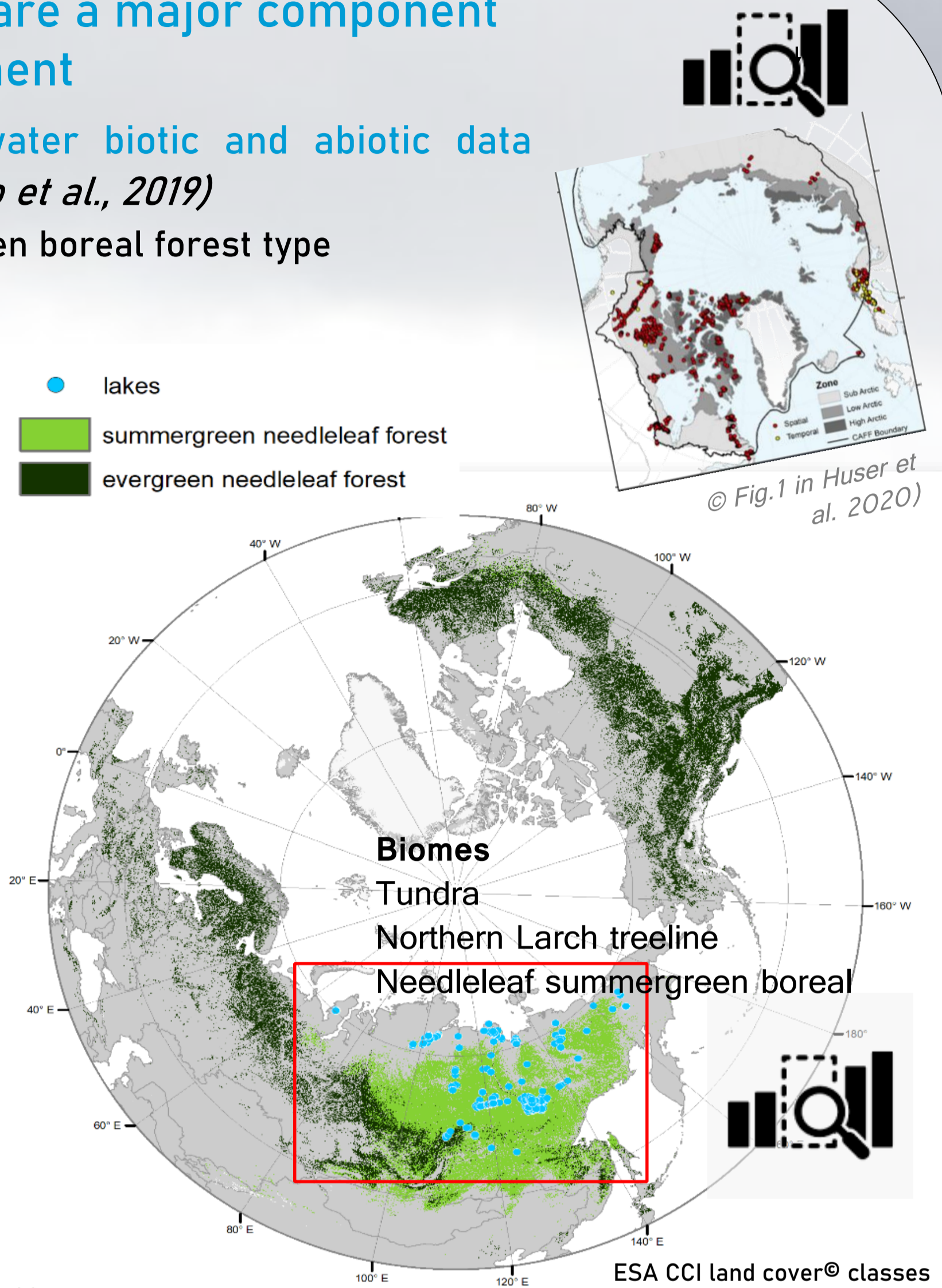*increased access and development in Northern environments, with unknown consequences for aquatic systems*

collection of *baseline water hydrochemistry* and ecological data, prior to major development, is an essential step in the management of Northern aquatic ecosystems.

minor seasonal thawing (supra permafrost groundwater)

determines

major surface runoff during snow melt, inflowing streams

determine

Northern lake hydrochemistry

determines

Northern aquatic ecosystems
Northern aquatic biodiversity
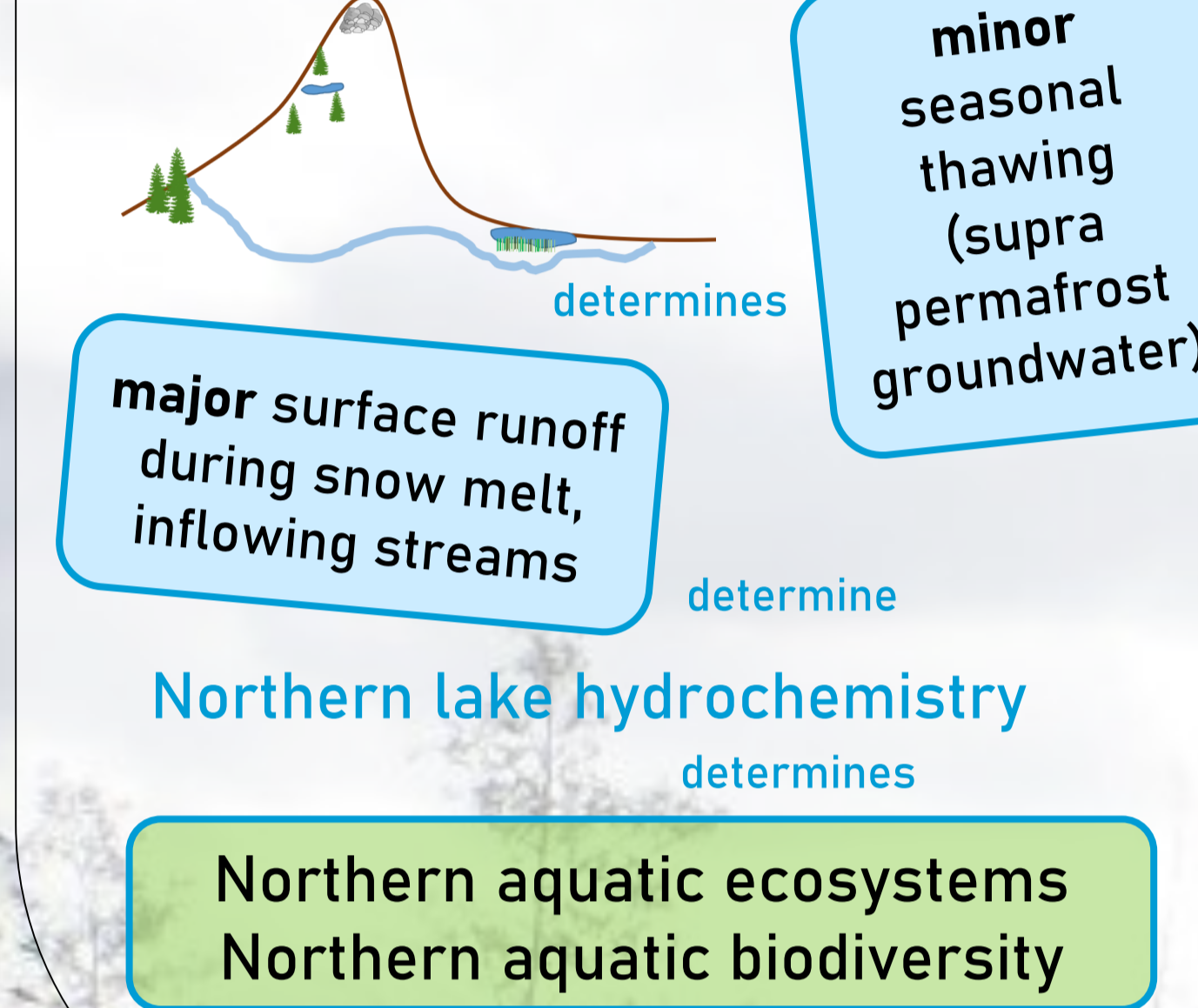
Freshwater ecosystems are a major component of the Northern environment

published circumpolar freshwater biotic and abiotic data (CAFF: Huser et al., 2020, Lento et al., 2019)

data gaps: Siberia & summergreen boreal forest type

We aim to standardise, rescue & publish data on lake hydrochemistry from past Russian-German scientific cooperation in Central and Eastern Siberia. The data compilation to date is composed of hydrochemistry sampling data sets from around 500 lakes collected in the past 30 years, mostly representing ice-free summer state, sometimes multi-seasonal and multi-annual. The sampled lakes span from permafrost lowland to glacial lakes in mountain regions and along taiga-tundra transects.

lakes
summergreen needleleaf forest
evergreen needleleaf forest

© Fig.1 in Huser et al. 2020

Biomes
Tundra
Northern Larch treeline
Needleleaf summergreen boreal

ESA CCI land cover© classes

III Metadata

Ongoing project: 2022-2023

HMC   IGSN   GFZ Helmholtz Centre Potsdam

Partners and Use Cases

AWI   GFZ Helmholtz Centre Potsdam   hereon

Arctic land expedition samples from Russian-German expeditions

Rock samples and samples from the Ketzin pilot site

Automated IGSN assignment for Biogeochemical Sample Database

FAIR WISH   FAIR Workflows to establish IGSN for Samples in the Helmholtz Association

level of digitalisation

- Metadata recommendations for BioGeo samples
- Controlled vocabularies
- IGSN registration with GFZ Data Services

https://zenodo.org/communities/fair_wish

endorsed by:

IASC Terrestrial Mosaic

Warwick Vincent,
Centre d`études nordiques
CEN@ Laval, Canada

João Canário, Centro de Química Estructural,
University Técnica de Lisboa, Portugal

Kirsten Elger, GFZ Data Services, German
Research Centre for Geosciences, Potsdam,
Germany

The new lake data collection is rich in standardised metadata following the IGSN metadata schema. Within FAIR WISH we customised the GFZ-specific IGSN schema to better describe the feature of interest: lake and the water and lake sediment core samples in a hierarchical (parent and child) scheme, including information on lake and sample characteristics, ecoregions, PIs and many more.

parent **IGSN**:
Lake

1. child **IGSN**:
Water sample

2. child **IGSN**:
anorganic Chemistry
organic Chemistry
Phytoplankton
DNA
Further samples

1. child **IGSN**:
Sediment core /
Sediment surface sample

2. child **IGSN**:
Core sections

3. child **IGSN**:
Core samples
carbon age
elements
isotope
ancient DNA
Pollen
Diatoms
Chironomidae
Further samples

Sample-specific metadata recommendations

Legend:
- IGSN registration schema
- IGSN description schema
- GFZ specific description schema
- Vegetation sample specific metadata
- Sediment sample specific metadata
- Water sample specific metadata
- Rock sample specific metadata

Vegetation   Sediment   Water   Rock

FAIR WISH controlled vocabularies (SKOS/RDF) (e.g., for environmental descriptors) https://doi.org/10.5281/zenodo.6787199

	+ PI ORCIDs	+ Lake IGSN	Lake Code-1	Lake Code-2	Lake name	Sample Name	+ Sample IGSN
			L01	02-Ch-01	Улахан Эбэ	02-Ch-01	
			L02	02-Ch-14	Балдыныкы	02-Ch-14	
			L03	02-Ch-12	Бютяйдях	02-Ch-12	
			L04	02-Ch-15	Самнагайдах	02-Ch-15	
			L05	79-Ch-01	Лоюрку	79-Ch-01	
			L06	79-Ch-07	Урасалаах	79-Ch-07	
			L07	02-Ch-05	Тарыых	02-Ch-05	

PID for physical samples

Template: https://doi.org/10.5281/zenodo.7520015
Documentation: https://doi.org/10.5281/zenodo.7147531

FAIR WISH Template

FAIR Samples Template provides the standardised sample descriptions. Users can identify metadata elements from the full schema that align with their samples. The template is the source for machine-actionable XML metadata used for IGSN registration.

Internal name	Geographical name	event type (v E	Longitude	Latitude	elevation	country	federal subject / state / rep	landform setting	landscape	lake type
EN21401	Lake Ulu	lake	63,33664	141,057	946	RU	Republic of Sakha - Yakutia	Oymyakonsky District	Boreal forest	mountain range	glacial lake
EN21402	NA	lake	63,32696	141,0843	989	RU	Republic of Sakha - Yakutia	Oymyakonsky District	Boreal forest	mountain range	glacial lake
EN21403	NA	lake	63,32012	141,0799	1036	RU	Republic of Sakha - Yakutia		Boreal forest	mountain range	glacial lake
EN21404	NA	lake	63,32943	141,1181	1000	RU	Republic of Sakha - Yakutia		Boreal forest	mountain range	glacial lake
EN21405	NA	lake	63,43886	140,3983	1260	RU	Republic of Sakha - Yakutia	Oymyakonsky District	Boreal forest	mountain range	glacial lake
EN21406	NA	lake				RU	Republic of Sakha - Yakutia		Boreal forest	mountain range	glacial lake
EN21407	NA	lake				RU	Republic of Sakha - Yakutia		Boreal forest	mountain range	glacial lake
EN21408	NA	lake							Boreal forest	mountain range	glacial lake
EN21409	NA	lake							Boreal forest	mountain range	glacial lake
EN21410	NA	lake							Boreal forest	mountain va	glacial lake
EN21411	NA	lake							Boreal forest	mountain va	glacial lake
EN21412	NA	lak							Boreal forest	mountain va	glacial lake
EN21413	NA	lak							Boreal forest	mountain va	glacial lake
EN21414	NA	lak							Boreal forest	mountain va	glacial lake
EN21415	NA	lak							Boreal forest	mountain va	glacial lake
EN21416	NA	lak							Boreal forest	mountain va	thermokarst
EN21417	Lake Imitte	lak							Boreal forest	mountain va	thermokarst

IGSN Descriptive Metadata GFZ Sample Elements

Semi-automated XML creation from template

II Data & Metadata Standardisation

Data: major cations and anions, alkalinity, pH and Electrical conductivity
- data harmonization and quality checks, coordinates corrections

Metadata – data without metadata are no data ☺
- sample processing in field (e.g. filtration, acidification), transport & storage, sample processing in laboratory (e.g. sensors)
- Persistent identifiers provided for sample (IGSN), feature of interest (lake: IGSN) and collected for PI (OrcID), Institutes (ROR), related sources (data, articles, code: DOI)

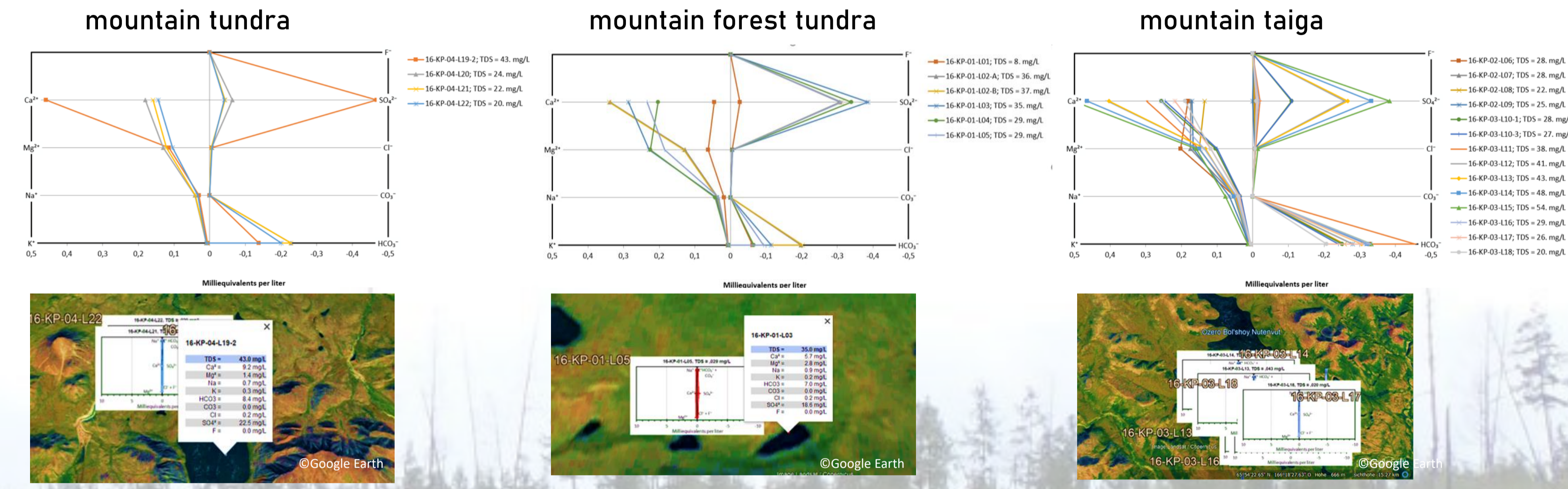IGSN – International Generic Sample Number: GFZ Example

UNDER CONSTRUCTION

- Globally unique **persistent identifier for physical samples** and materials
- IGSN connect sample with **online sample description** (link, QR Code)
- For individual and hierarchical samples (e.g. drilling projects)
- IGSN are **citable** in papers and data publications
- Closing one of the last gaps for the **full provenance of research results**

https://igsn.org/ICDP5054EX2Z501

IV Data Visualisation and Analyses

Major cations and anions

AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ
mg / L	mg / L	mg / L	mg / L	mg / L	mg / L	milliequivalent	milliequivalent	milliequivalent		mg / L	mg / L	mg / L	mg / L	mg / L	mg / L
Ca	Mg	Na^+	K^+	$\sum Na + K$	sum cations	Ca^+	Mg^+	$\sum Na^+ + K^+$	sum cations	PO_4^-	HCO_3^-	CO_3^-	Cl^-	SO_4^{2-}	F

major cations and anions in mg / L & milliequivalents, + commonly used sums, e.g., Mg + Ca, Na + K, CL + F

Stiff example: relative major ion composition across tundra to taiga [summer 2016, Siberia / Chukotka, RU]
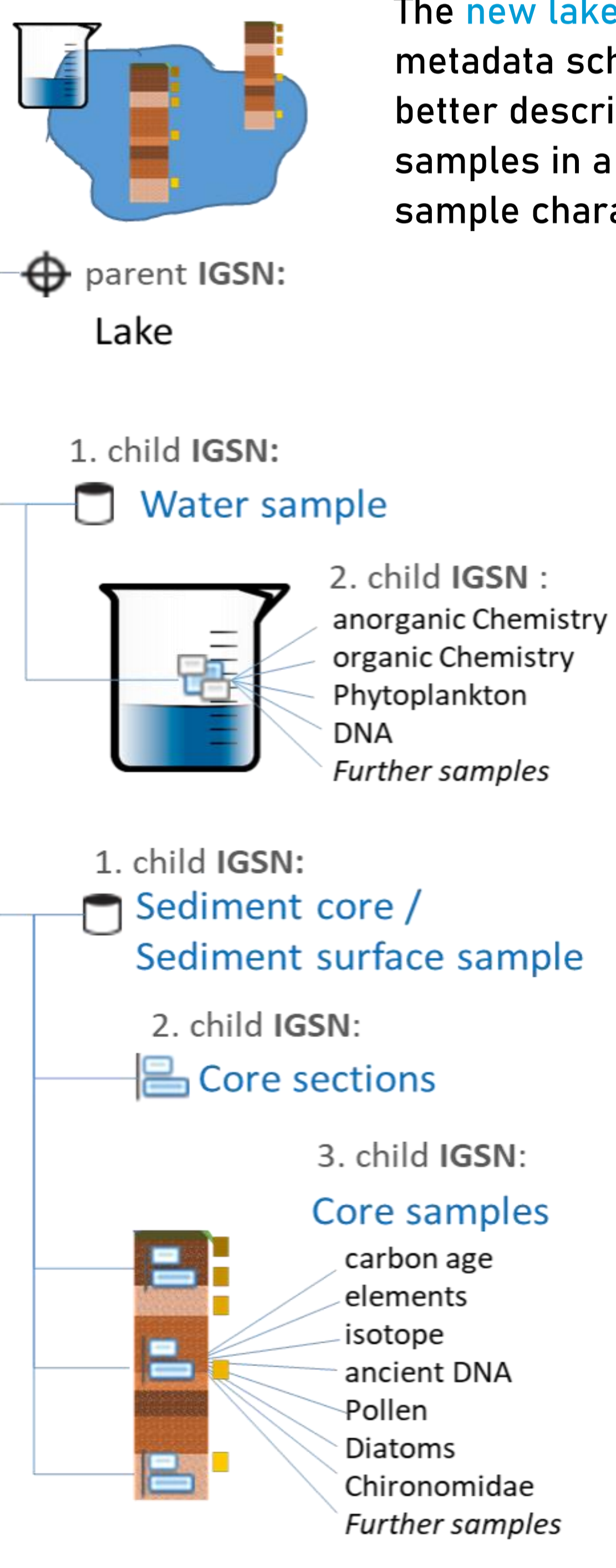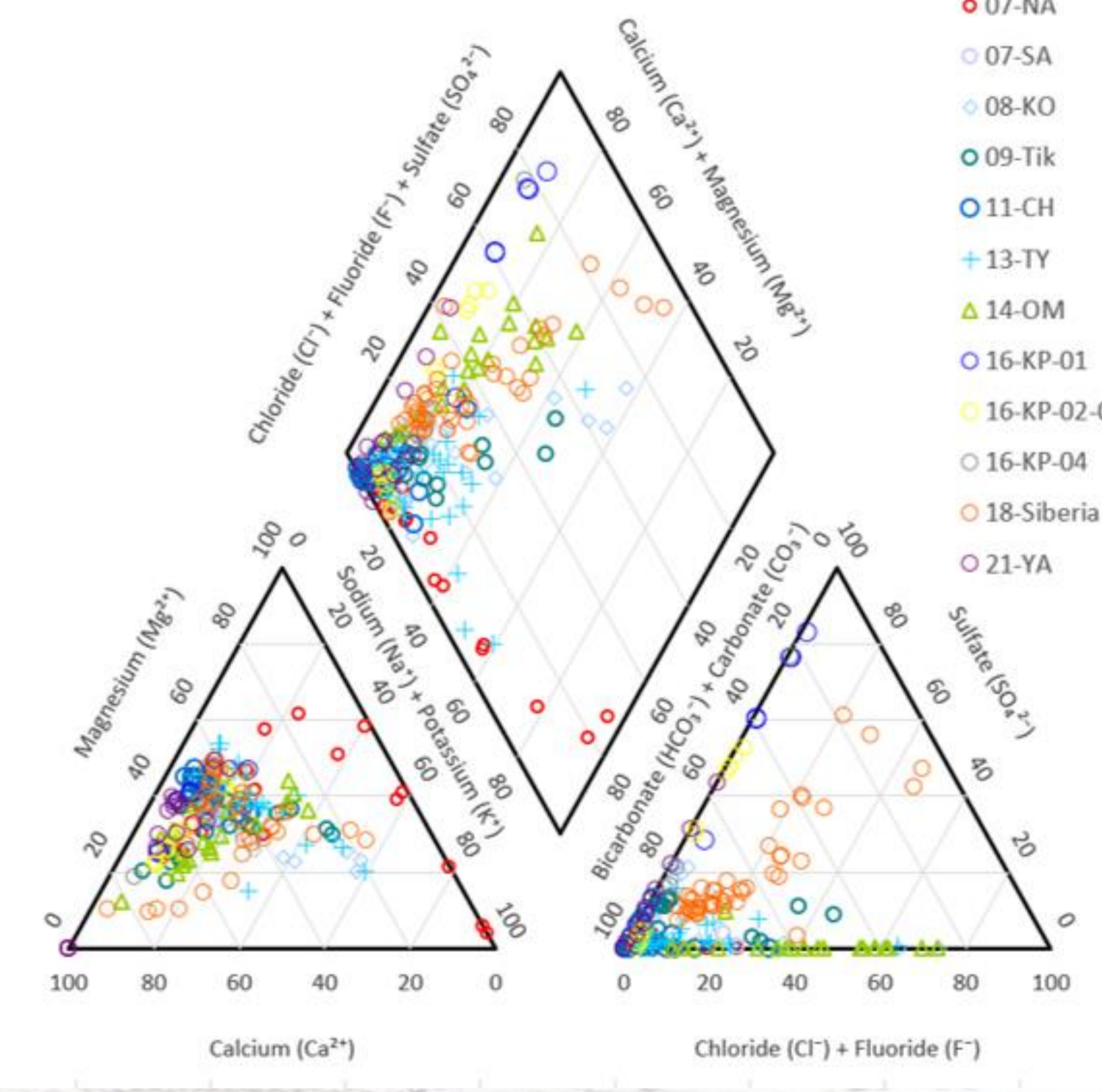
mountain tundra   mountain forest tundra   mountain taiga

Piper example: major ion composition across tundra to taiga transitions [summer 2007-2021, Siberia, RU]

transects along taiga and tundra and climate gradients, mountain vs. lowland, glacial and thermokarst lakes

2005
2006

- 07-NA
- 07-SA
- 08-KO
- 09-Tik
- 11-CH
- 13-TY
- 14-OM
- 16-KP-01
- 16-KP-02-03
- 16-KP-04
- 18-Siberia
- 21-YA

link major ion composition to catchment

UNDER CONSTRUCTION

Lake and catchment characteristics

UNDER CONSTRUCTION

Sentinel-2 20m classified
lake size
catchment size
land cover, disturbances
lake color

TanDEM-X 90m DEM:
elevation, slope, catchment

lake type (?)
lake depth
(SAR downfreezing?)

lithology/geology
[Russian maps (?)]

V Outlook

We are assigning and publishing lake and water sample IGSN including rich meta data.
This standardised hydrochemistry data collection representing a benchmark of the late 20th to the early 21st Century before wide-spread development in the Northern environment will be made available in the PANGAEA data repository (www.pangaea.de).
It will enable researchers to analyse land-to-lake geochemical fluxes and will support for biodiversity, biogeochemical, bioindicator and many more analyses.