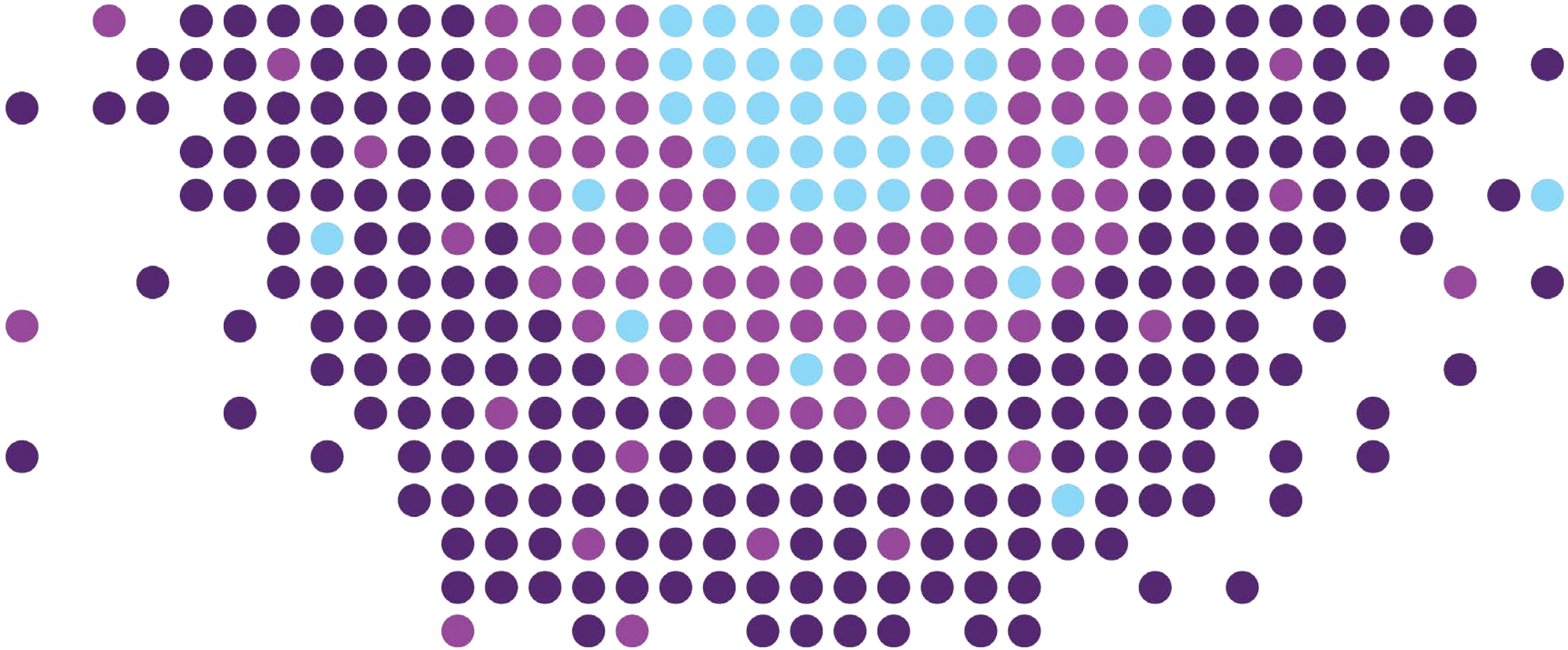

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Belgian Nuclear Research Centre

The waterbodies of the halo-volcanic Dallol complex (Ethiopia)

The waterbodies of the halo-volcanic Dallol complex: A physico-chemical and geo-microbial survey

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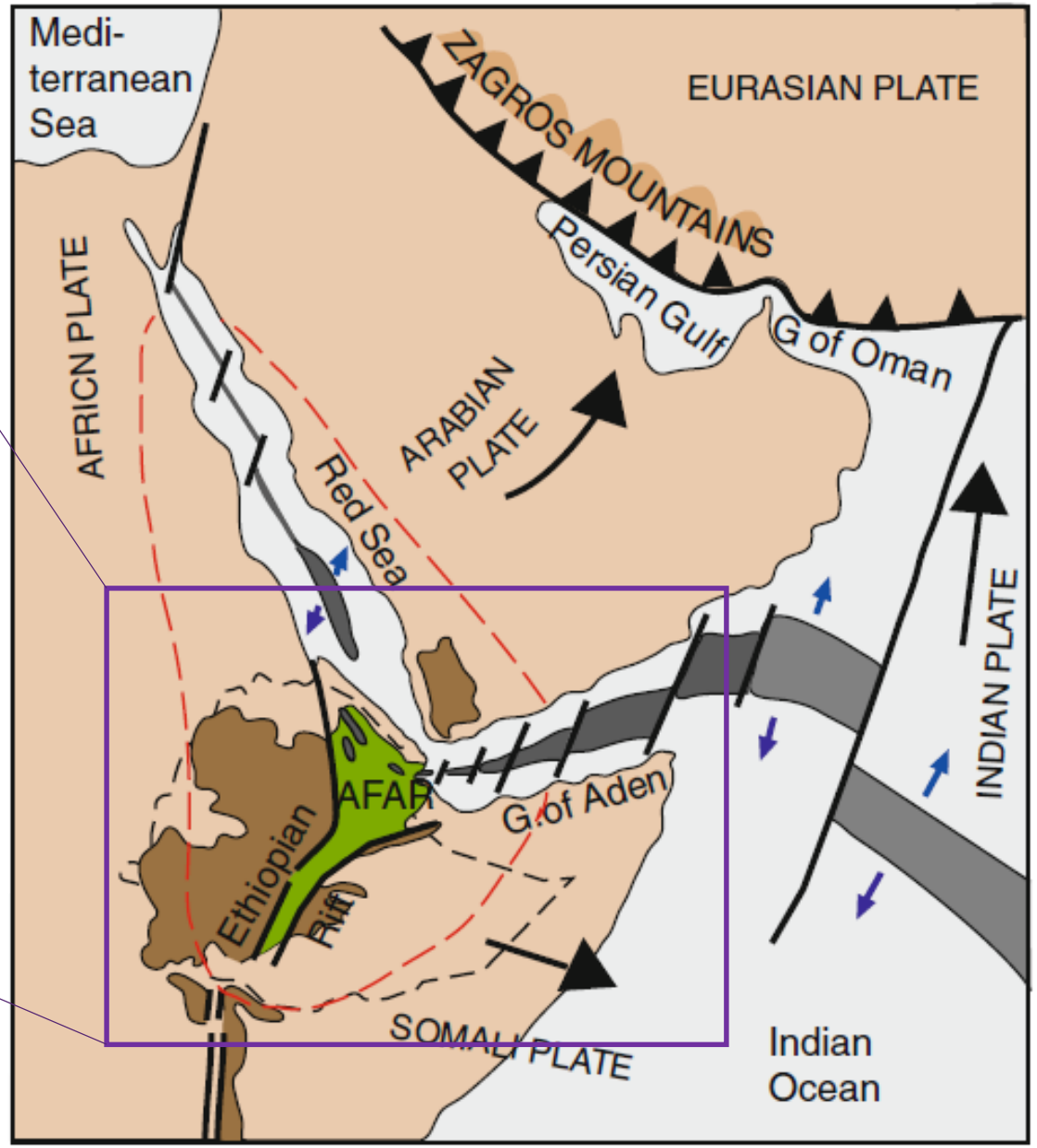
Session BG5.3 | D799 | EGU2020-1581

Winning picture: A photo celebration scientist at work 2018
Nature **556**, 525-527 (2018) *doi: 10.1038/d41586-018-04881-z*

The Afar triple junction: the breaking-up of a continent

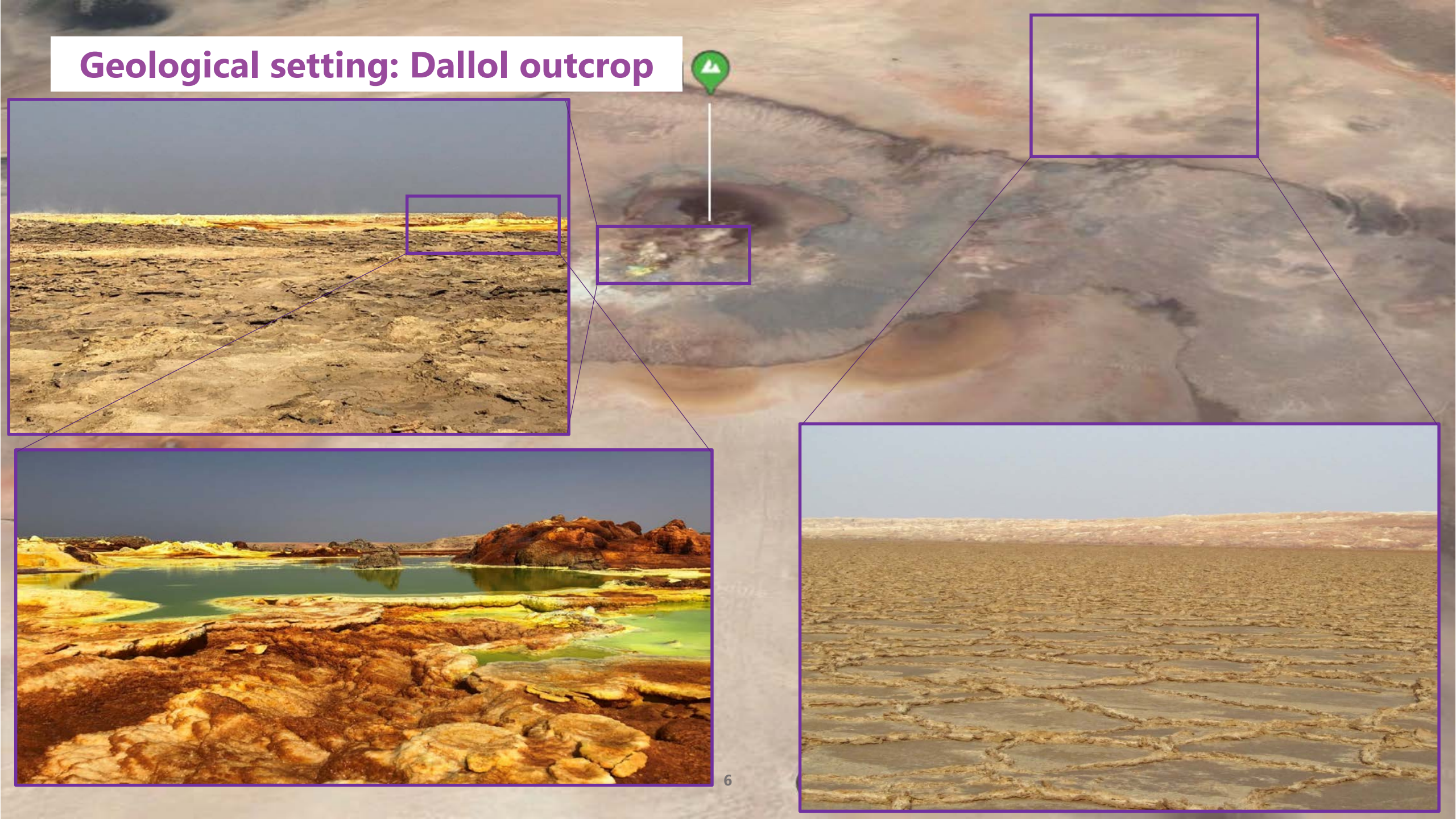
Google maps, 2018



Williams, 2016

Locations of the waterbodies

Geological setting: Dallol outcrop

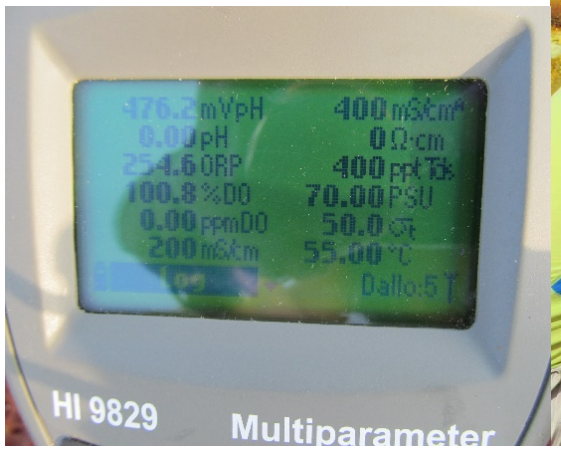


Geological setting: water bodies at the base of Dallol

Geological setting: water bodies in the salt plane

The field work: *in situ* measuring and sampling

- Liquid
  - *In-situ* parameter measurements
  - Sampling in “crimp-sealed, sterilized vacuum bottles”
  - Sampling in open bottles



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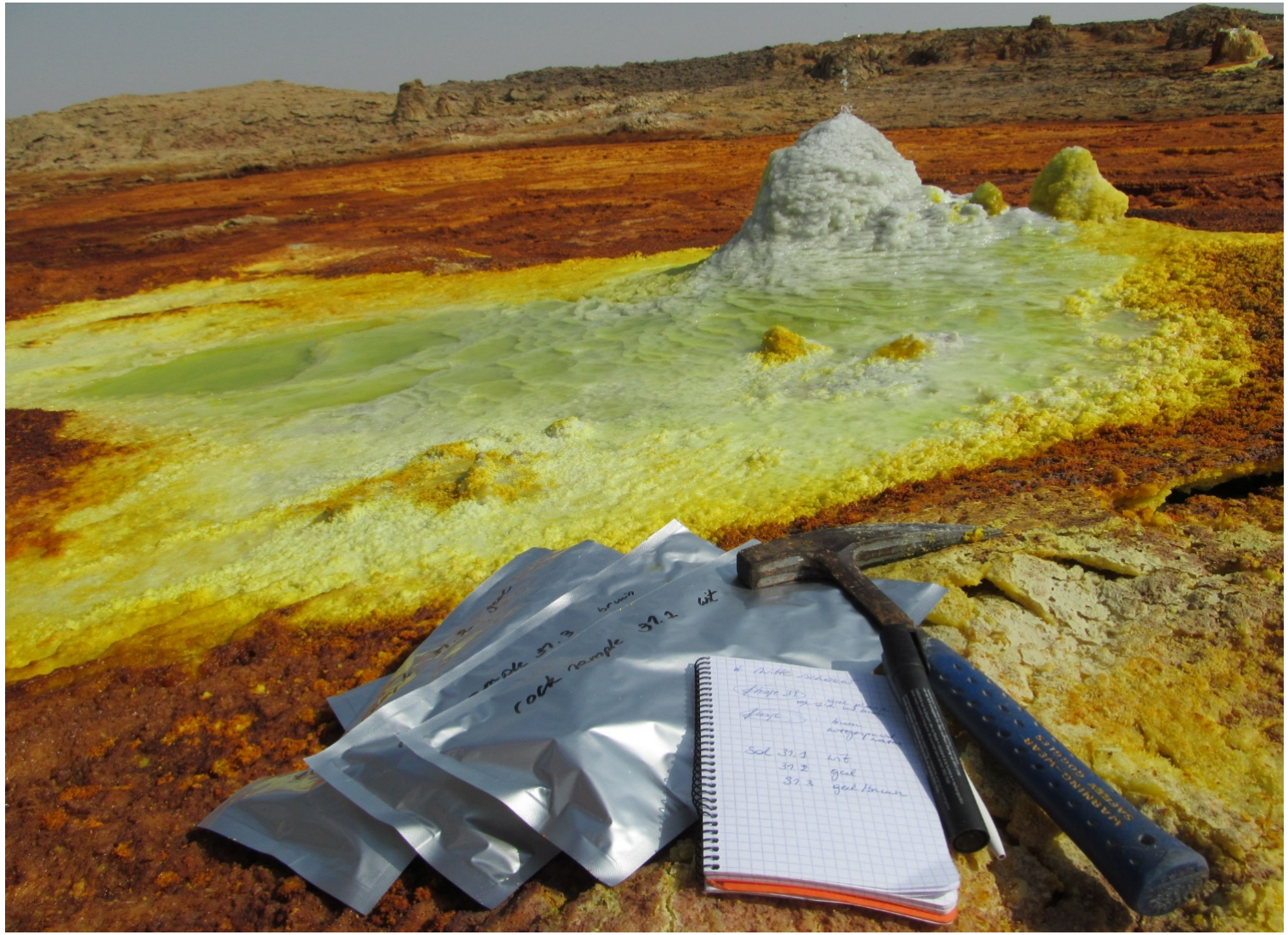
Reference: EGU2020-581

The field work: *in situ* measuring and sampling

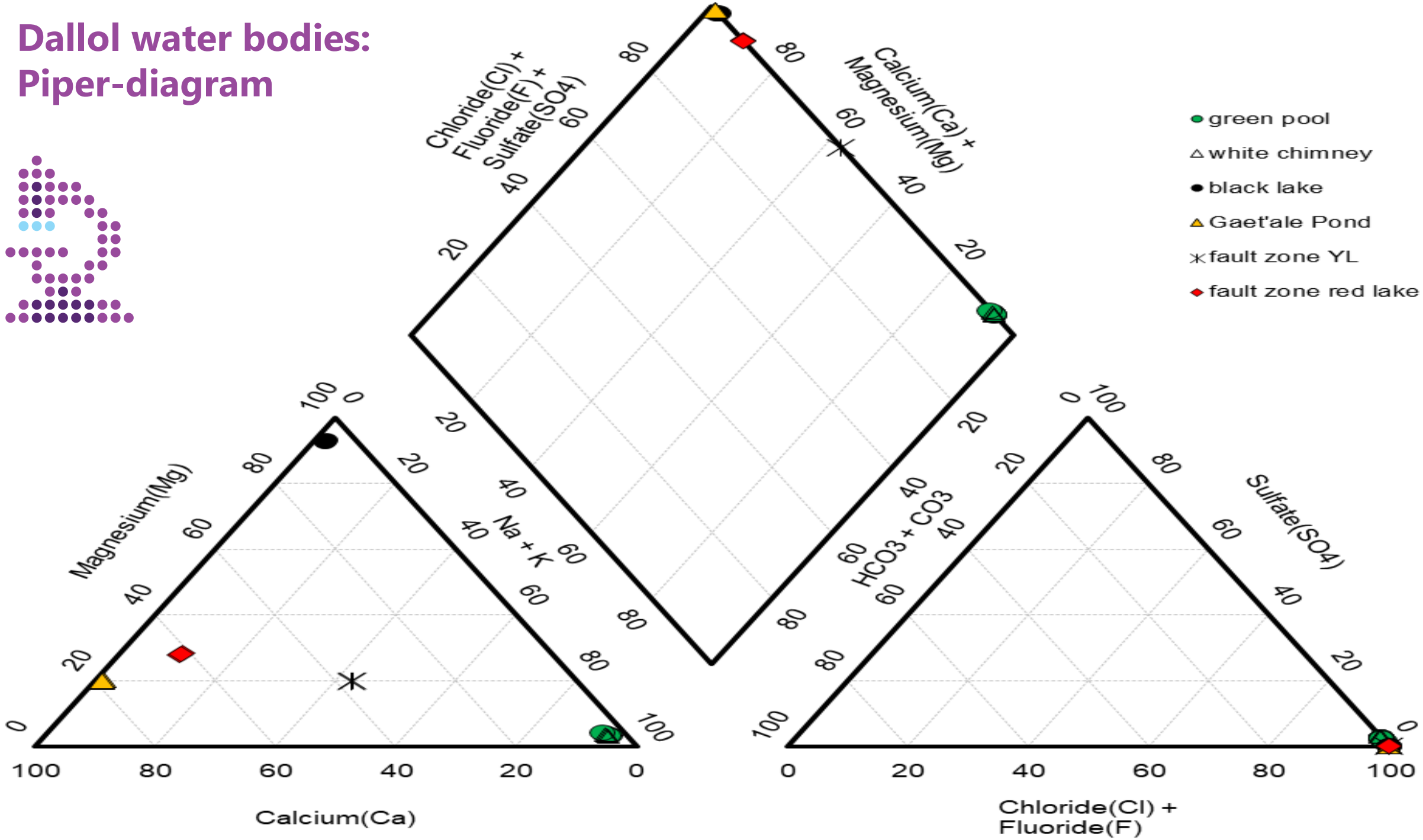
- Rock sampling



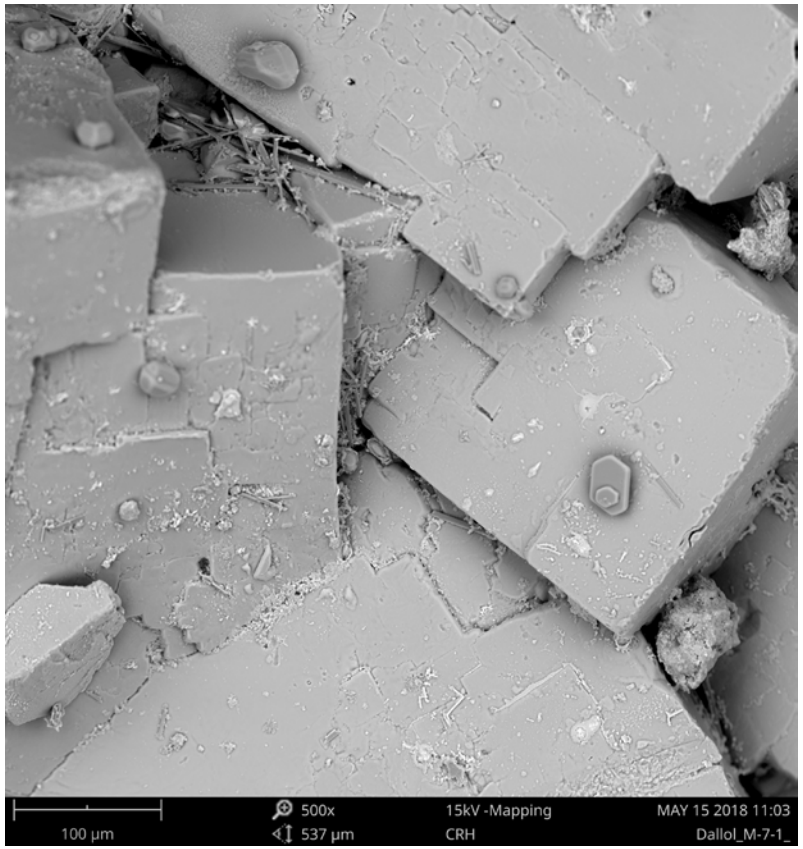
Geo-Physico Chemical characterisation of ten water bodies sampled in Danakil depression (Köppen climat zone: BWh)

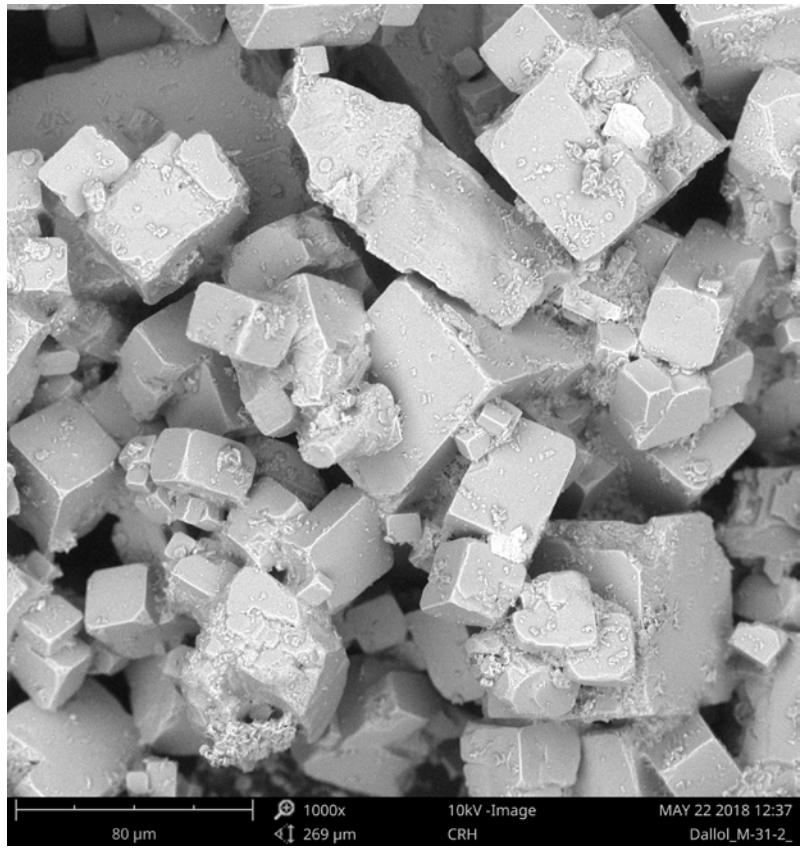
Parameter	Gaet'ale Pond Yellow lake	Yellow mini pond	Red round mini pond	Central green pool	Left green pool	Right yellow pool	White chimney environment	Black lake	Asale karst hole	Karum Lake
Location										
GPS Latitude	14°12'48.1" N	14°13'40.4" N	14°13'41.7" N	14°14'10.8" N	14°14'10.6" N	14°14'10.8" N	14°14'11.5" N	14°13'18.4" N	14°06'57.6" N	14°02'58.0" N
GPS Longitude	40°19'17.1" E	40°19'08.1" E	40°19'06.3" E	40°18'00.5" E	40°18'00.2" E	40°18'00.8" E	40°17'59.5" E	40°17'10.6" E	40°20'53.2" E	40°22'32.2" E
Water analyses										
in-situ measurements										
Temperature [°C]	41.2	32.0	35.1	46.1	34.0	35.5	>100	35.7	35.5	31.5
in situ pH	6.2	4.7	3.1	- 0.5	- 0.5	- 0.4	- 1.1	2.4	5.6	5.4
Conductivity [mS.cm^{-1} at 25°C]	> max.	> max.	> max.	> max.	> max.	> max.	> max.	> max.	> max.	> max.
E_H [mV versus SHE]	336	296	434	556	569	595	466	396	382	392
Laboratory Physico-Chemistry										
Temperature [°C]	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
$pH_{1/50\ diluted}$ [at 25°C]	3.4	3.7	3.5	0.7	0.8	0.9	0.7	2.8	4.4	4.5
Conductivity [mS.cm^{-1} at 25°C]	598	395	494	422	418	404	424	521	373	375
E_H [mV versus SHE]	460	396	426	620	619	630	627	478	407	416
Specific gravity [Mg.m^{-3}]	1.454	1.246	1.342	1.225	1.223	1.222	1.223	1.351	1.220	1.218
TDS measured [g.l^{-1}]	682	373	504	314	319	320	318	434	352	350
Water activity A_w [-]	0.234	0.684	0.463	0.725	0.728	0.731	0.729	0.324	0.734	0.735
Major Cations, ICP-MS [mM]										
Na^+	58	2 091	245	3 893	3 846	4 153	3 746	88	3 519	4 149
Mg^{2+}	1 925	1 106	2 016	156	157	148	128	4 705	124	115
Ca^{2+}	4 048	1 267	2 685	85	84	79	80	207	434	424
K^+	40	260	322	195	197	168	157	46	90	88
$Fe^{2+/3+}$	1	10	4	273	280	226	221	27	0.3	0.3
Sr^{2+}	34	11	30	1	1	1	1	3	4	4
$[B(OH)_3]^0$	8	3	6	17	15	12	15	4	1	1
Major Anions, IC [mM]										
Cl^-	12 168	6 767	10 704	5 834	5 665	5 857	5 602	10 077	5 211	5 887
F^-	<	4	11	18	16	14	17	<	<	<
Br^-	95	30	67	3	3	3	3	116	10	9
SO_4^{2-}	<	2	<	58	54	42	61	<	3	4
PO_4^{3-}	<	<	<	<	<	<	<	<	<	<
NO_3^-	<	<	<	<	<	<	<	<	<	<
NO_2^-	<	<	<	<	<	<	<	<	<	<
HCO_3^-	4	<	<	<	<	<	<	<	4	5
CO_3^{2-}	<	<	<	<	<	<	<	<	<	<
Charge Balance [mEq]	49	276	-739	-836	-690	-717	-966	-171	-492	-579
TDS analysed [g.l^{-1}]	651	380	564	336	326	337	333	494	294	332
TDS relative difference [%]	5%	-2%	-11%	-6%	-2%	-5%	-4%	-12%	20%	6%
Mineral analyses										
XRD-mineral analysis	NaCl, KCl, $CaMg_2Cl_6.12H_2O$, $MgCl_2$	NaCl, $CaMg_2Cl_6.12H_2O$	KCl, $KMgCl_3.6H_2O$	NaCl, KCl, $CaSO_4.12H_2O$, $Ca(Mn,Mg)(CO_3)_2$	NaCl, KCl, $CaSO_4.12H_2O$, $Ca(Mn,Mg)(CO_3)_2$	NaCl, KCl, $CaSO_4.12H_2O$, $Ca(Mn,Mg)(CO_3)_2$	NaCl, KCl, $CaSO_4.12H_2O$, $Ca(Mn,Mg)(CO_3)_2$	$MgCl_2.6H_2O$, $KMgCl_3.6H_2O$	NaCl, KCl	NaCl, KCl
	halite, sylvite, tachyhydrite, chloromagnesite	halite, tachyhydrite like	sylvite, carnalite	halite, sylvite, gypsum, kutnohorite	halite, sylvite, gypsum, kutnohorite	halite, sylvite, gypsum, kutnohorite	halite, sylvite, gypsum, kutnohorite, anhydrite	bischofite, carnalite	halite, sylvite	halite, sylvite

Dallol water bodies: Piper-diagram



Mineralogical analyses: halite, silvite and gipsum





Geo-Microbiology

- Microbial activity: All ATP levels were around or below detection level
- 16S rDNA microbiological fingerprinting:
  - Very high DNA contamination bias in all lake samples:
    - Anthropogenic contamination ECO Tourism, laboratory, …
    - Microbiomes contaminations from migrating birds, bats, dragon flies, …
    - Global airborne contaminations from Sahara winds, desert storms, salty sea/lake dusts
  - **Dallol outcrop lakes**: no indigenous species detected
  - **Lakes at the Dallol base**: no indigenous species detected
  - **Salt plane lakes**: potential presence of halophilic microbes e.g. *Haloplanus, Salinibacter, Natronarchaeum*

Dead animals on the shore of Gaet'ale Pond

- Cultivation attempts in Sulfolobulus (88), Sehgal and Gibbons (1336), Halobacterium (97), Salinibacter (936) and an own designed SAM-medium:
  - Cultivatable halophilic microbes detected in SAM-medium cultures of **Karum Lake** and **Asale Karst hole**: *Candidatus_Nanosalina_unclassified* and *Limimonas sp.*

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