CRYOPAM: Investigating high altitude cryosphere processes in the Pamir

Fan Mountains , Tajikistan, August 2019

Expedition Report

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Gratefully supported by the Mount Everest Foundation

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Background

Permafrost is still a poorly understood phenomenon in High Mountain Asia. However, we know from the European Alps that permafrost is thawing under climate change and causing severe slope instabilities that threaten both lives and infrastructure. Lakes forming in mountain regions as glaciers melt can catastrophically outburst as GLOFS due to failure of ice cored dams or flood waves from permafrost slope failures. In addition, permafrost is starting to be recognized as a potentially important water resource, particularly in arid regions where ground ice will persist long beyond the disappearance of glaciers. Despite the importance of permafrost for both mountain hazards and mountain hydrology we lack key knowledge throughout High Mountain Asia and specifically throughout the Pamir. This project serves as a first effort to establish a long term monitoring site in Tajikistan in collaboration with the Tajik Agency for Hydro-meteorology as well as build local expertise in Government agencies and Tajik Academy of Sciences. A Phase 2 is planned in 2020.

Location, access and logistics

The expedition location was the Fann mountains in the western Pamir-Alay range (Fig 1 and 2). This location was chosen due to access to high elevation periglacial environments as well as accessibility from Dushanbe which would facilitate data retrieval. Additionally, an ongoing project from the Finnish Meteorological Institute has installed a meteorological station and performed glaciological measurements in the same region. Future collaborations are planned to optimally combine our respective measurements.

Access from Dushanbe is relatively straightforward by taxi in 4h and a 4x4 is not necessary in dry summer conditions. There are various simple accommodation options in the region, many of which are remnants of a former tourist infrastructure based around mountaineering during the soviet era. The area sees some foreign climbers today but mainly in the Chimtargha region. We saw only one herder during our entire expedition. There are no peak fees and e-visa's are straightforward to obtain online, therefore bureaucracy is fairly simple.

The expedition followed a strict leave no trace policy. Toilet practices followed best practice of K. Meyer ('How to shit in the woods' 3rd edition). Organic material was buried below the tree line and all waste was carried out to Dushanbe for disposal in municipal waste bins. All batteries were flown out for correct disposal in Switzerland.

Fig 1: Location of the expedition in the Fann Mountains, Tajikistan.

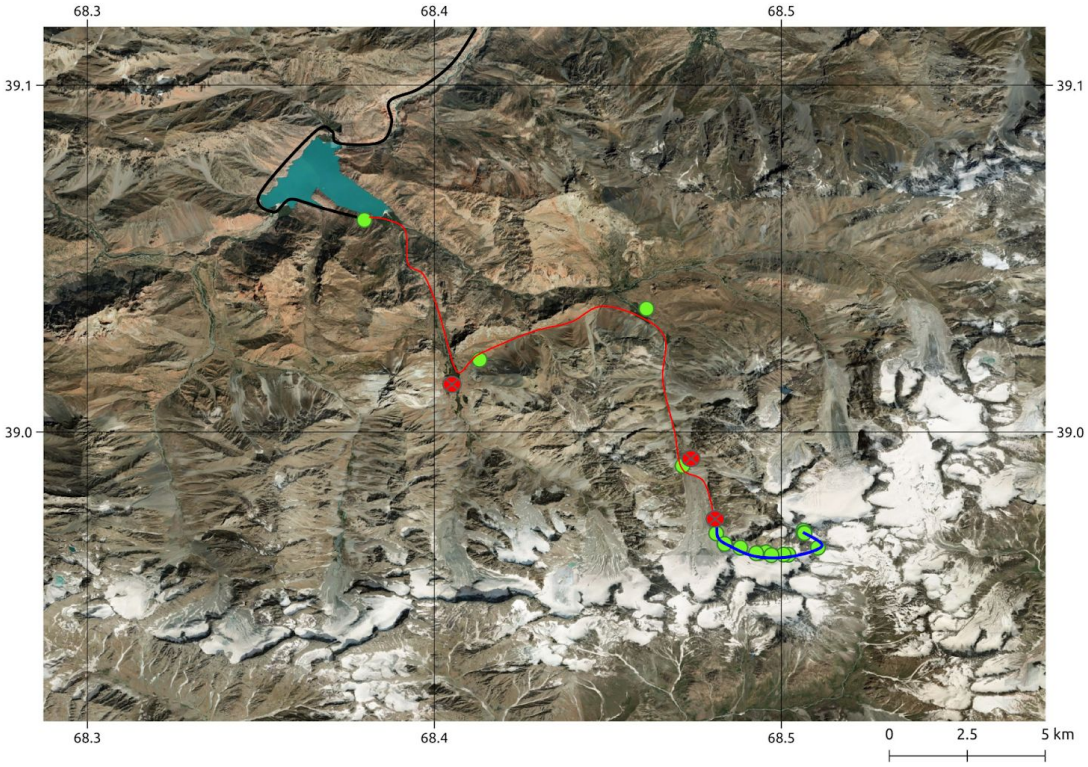

Fig 2: Expedition region in the Fan mountains near Iskanderkul ("Alexander Lake", named after Alexander the Great who is said to have passed this way). Dirt road access in black, approach in red, climb in blue. Camps in red circles. Permafrost logger locations in green. Elevation ranges from 2000m asl at Iskanderkul to almost 5000m asl on the highest peaks such as our expedition objective.

Fig 3: Basecamp at 3750.m asl. Glacier ramp leading to base of the South-East ridge of Pt. 4820 is seen centre.

Science programme

JF (leader) works closely with the Swiss Permafrost Monitoring Network (PERMOS) which is a global leader in high mountain permafrost research. We adopted PERMOS best practice and field protocols in this project.

The main aim was to establish an elevation profile of ground temperature measurements from 2000 - 5000m asl (Fig 2). As such we chose largely flat locations to control for the effect of slope and aspect on the surface energy balance. However we do investigate these factors at a couple of sites (L7/L8) namely on the summit ridge. The lowest loggers are well below the lower limit of permafrost and will be used to help delimit this boundary but also investigate other surface energy balance questions.

We deployed 3 types of logger (Table 1, due to the availability of existing loggers at SLF and budget from this project to purchase new equipment). All are capable of sampling at 20 min intervals for at least the next 5 years and have been well tested in harsh conditions in the Swiss Alps. Loggers are either buried in sediments at 10 cm depth (to remove direct solar insolation) or deployed in voids in blocky material.

Table 1: Logger types deployed during this expedition.

Type	**M-Log5W-ROCK**	**M-Log5W-SIMPLE**	UTL-3
Accuracy	+/- 0.1°C (at 0°C)	+/- 0.1°C (at 0°C)	0.1 °C at +/- 20 °C
Resolution	0.01°C	0.01°C	< 0.1° C
Storage datapoints	400000	400000	65000

Battary life years	7-10	7-10	3-5
			
Web	http://www.geoprecision.com/en/produkte-en/funk-datenlogger-433mhz-en	http://www.geoprecision.com/en/produkte-en/funk-datenlogger-433mhz-en	https://www.geotest.ch/kompetenzen/messen-ueberwachen/utl-3-temperature-datalogger.html

This logger data has three main purposes:

1. A first observation of the ground thermal regime in this region so we understand the current situation.
2. Long term permafrost monitoring as a network managed by Hydromet to detect trends as well as ranges of interannual variability.
3. Model validation data, perhaps the most useful aspect of this logger data is that it is an integral of the surface energy balance ie energy in - energy out. This means it is a really cost effective way to validate our impact models in mountain regions with important applications from natural hazards to water resources.

This expedition was a pilot project which paves the way for further work in 2020. Namely, we will be establishing a full meteorological station in central Pamir and working with the Academy of Science as well as Hydromet again, in data retrieval and initial analysis.

The ascent of Pt 4820

The main ascent of Pt 4820 allowed us to extend our elevation profile to almost 5000m. The ascent started as a straightword snow couloir (could be avoided by rock ledge system on climbers left) followed by a broad block ridge to the summit. Total ascent time from basecamp was 4h and the route would be graded as Alpine F. The lower part of the couloir could be exposed to (minor) stonefall, but otherwise the route was objectively very safe. We purposefully searched for a technically straightforward route to facilitate retrieval of data in subsequent expeditions.

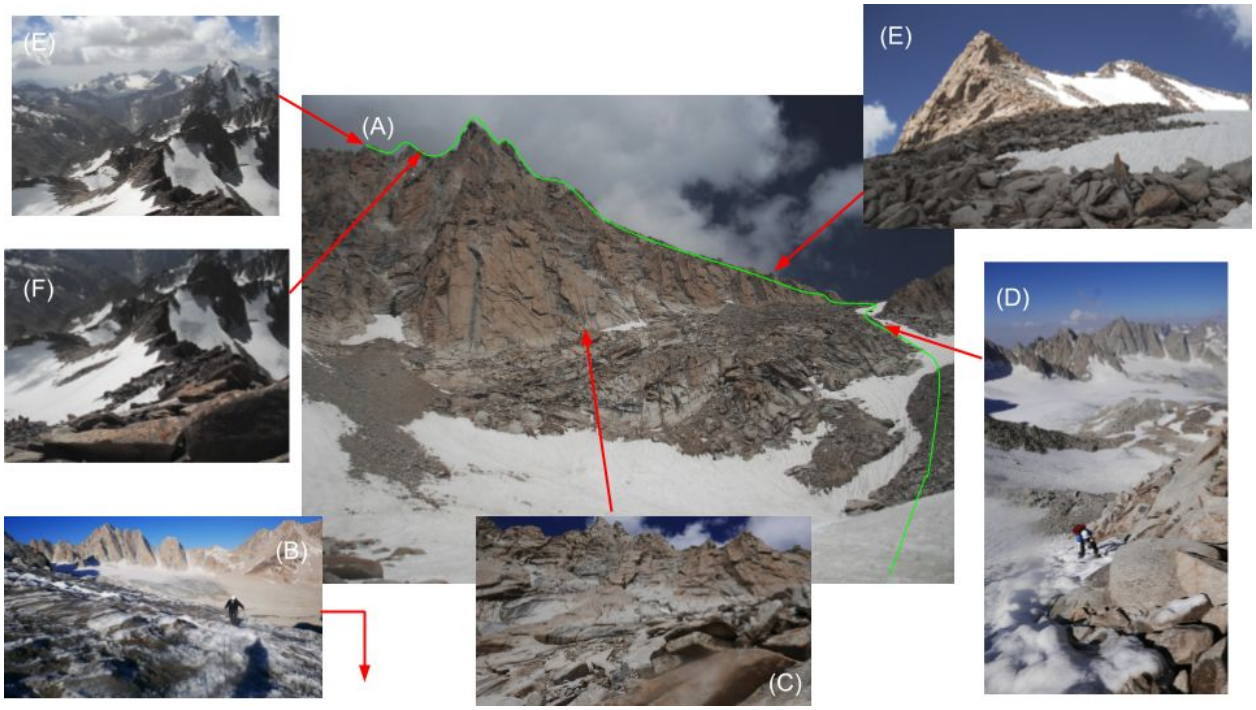

Fig 4: (A) South-East ridge ascent of Pt 4820 (unnamed peak). (B) Approach on glacier. (C) View of impressive South wall. (D) Climbing South couloir. (E) View up broad South-East ridge to tower. (F) View down block ridge above the tower. (E) View from the summit.

State of Glaciers and other points of Interest

This section documents through photos some additional noteworthy observations of glaciers, geo-processes or wildlife during the expedition.

Glacier terminus at 3800m asl

On top of the terminus ramp looking towards western side of catchment.

Glacier is retreating and downwasting rapidly at its northern edge. Accumulation zone starts at around 4100m asl.

Bear print at around 3300m asl, leading the way to basecamp!

Endangered Saker Falcon found on the trail at around 2200m asl (several live ones seen during expedition).

Evidence of subglacial outburst at base of hanging glaciers.

Likely relict rock-glacier (permafrost generated landform) at around 3200m asl. There are numerous intact rock-glaciers in this catchment at high elevations (starting zone c. 4000m asl.). These are certain signs of permafrost existence.

Penitentes at around 4700 m asl related to strong snow sublimation at high altitude.

Future climbing objectives

The region really looked like a possible granite climbing mecca with pinnacles, impressive pillars and steep south facing walls. If you plan a trip here please contact me so I can get you to pick up some data while you’re there! (joel.fiddes@gmail.com)

An interesting mixed objective due south of our summit

An interesting granite pillar of around 700m length.

A steep south facing granite wall under the main South-East ridge that we climbed.

Expedition Accounts

ITEM	QTY	UNIT PRICE (CHF)	PRICE (CHF)
Flights	2	1100	2200
Hotel / food Dushanbe	6	70	420
Taxi	1	120	120
Expedition supplies	1	400	400
Water filter	1	100	100
GPS	1	100	100
Logger equipment	1 (in sum)	2347	2347
TOTAL			**5687**

Income:
The only dedicated funding this expedition received was the MEF grant of 2900 GBP. The expedition benefitted from participants already being in the region due to other activities.

Acknowledgements

Many thanks to the Mount Everest Foundation for their generous financial support that mainly financed the logger equipment in this expedition. Thanks to Muzaffar Shodmonov at Tajik Hydromet who is a good colleague and main in country contact both on the science and logistics. Thanks to Antti Hyvarien at Finnish Meteorological Institute and heads the FinTaj project for valuable discussions in Dushanbe, as well as for deploying a logger at the FinTaj meteo station.

APPENDIX 1: Logger metadata

UUID	NAME	ID	GARMIN WP	LON	LAT	ELE	Date	Deploy Time (UTC)
1	L1	A53B39	1	68.41305	39.02084	3041.869	2019/08/25	5:24:00
2	L2	A53B34	2	68.47156	38.99025	3474.881	2019/08/25	12:16:12
3	L3	A53B37	6	68.49361	38.96507	4060.439	2019/08/26	9:15:49
4	L4	A53B38	7	68.4956	38.9653	4084.021	2019/08/26	9:45:42
5	L5	A53B36	8	68.48125	38.97075	3732.416	2019/08/26	14:16:09
6	L6	A53B3E	9	68.50634	38.97151	4820.554	2019/08/27	6:18:54
7	L7	UTL2560	10	68.50642	38.97086	4772.698	2019/08/27	6:52:51
8	L8	UTL3046	11	68.5067	38.97084	4767.014	2019/08/27	7:02:43
9	L9	A538DB	16	68.51057	38.96664	4519.345	2019/08/27	8:03:13
10	L10	A53B3B	18	68.50207	38.9646	4187.891	2019/08/27	9:11:34
11	L11	A538D8	19	68.50064	38.96466	4180.48	2019/08/27	9:41:17
12	L12	UTL3747	20	68.49717	38.96448	4136.72	2019/08/27	9:58:42
13	L13	UTL2762	21	68.49275	38.96504	4041.496	2019/08/27	10:24:02
14	L14	UTL3549	22	68.48821	38.96662	3969.259	2019/08/27	10:52:58
15	L15	UTL1210	23	68.48367	38.96772	3781.036	2019/08/27	11:42:37
16	L16	UTLSN1017	24	68.46115	39.03555	3017.004	2019/08/28	5:07:45
17	L17	A53B3A	43	68.37984	39.06112	2237.651	2019/08/28	11:41:57

slp	asp	Access code	surface	tz	period	Logger type	Notes
0	NA	C1B2	pasture	UTC	20	M-Log5W-SIMPLE	above camp1
0	NA	473	sand/silt	UTC	20	M-Log5W-SIMPLE	camp2
0	NA	533	sand/silt	UTC	20	M-Log5W-SIMPLE	
0	NA	173	large blocks	UTC	20	M-Log5W-SIMPLE	
0	NA	C5F2	silt/gravel	UTC	20	M-Log5W-SIMPLE	BC
0	NA	03F3	large blocks / silt infill	UTC	20	M-Log5W-SIMPLE	Summit

20	230	NA	gravel	UTC	20	UTL3	5m to climbers left of main ridge
20	130	NA	blocky void	UTC	20	UTL3	15-20m to climbers right of main ridge
0	NA	7832	moist sediment (snowmelt)	UTC	20	M-Log5W-SIMPLE	logger from tibet (2017), watch battery!
0	NA	0033'	moist silt	UTC	20	M-Log5W-ROCK	rocklogger (external probe)
0	NA	7972	block void	UTC	20	M-Log5W-SIMPLE	logger from tibet (2017), watch battery!
0	NA	NA	moist silt	UTC	20	UTL3	
0	NA	NA	silt	UTC	20	UTL3	
20	180	NA		UTC	20	UTL3	
20	270	NA		UTC	20	UTL3	
0	NA	NA		UTC	20	UTL3	
0	NA	C0F2/CO F2	gravel	UTC	20	M-Log5W-ROCK	access code issue / rocklogger