KRUBERA-VORONJA CAVE



International Expedition

August 2009

Stephen Macnamara, Tony Furnell Shannon Group

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1. Introduction

My introduction to the "Aenigma" caving club was in 2007, soon after moving to Lithuania. At first I was intrigued as to how a caving club could survive in a flat country with only two known caves, each less than fifty metres long. However, any scepticism was quickly wiped out when I found an extremely active club with more than 50 members, who had weekly training meets.

As the nearest significant caves are in southern Poland, some 870 km from Vilnius, and at least 1 day's solid driving across very rough Polish roads, all of Aenigma's caving requires expedition planning. My first trip with them was a March 2008 expedition to Aghnahoo, Co. Fermanagh no less, where 10 Lithuanians were shown the delights that Ireland has to offer. After the luxury of the 'Hoo, our next expedition involved proper camping in the forest, in the Alek karst region of south Russia (near the Black Sea), in April 2008.

Figure 1.1: Cave Near Forest Campsite, Alek Expedition 2008



I moved back to Ireland in July of the same year, but it wasn't long before I was travelling east again. Aidas Gudaitis, then Aenigma club captain, had many caving contacts both eastwards to Russia and westwards to the rest of Europe. He offered his help to Yuri Kasjan, expedition leader in the "Call of the Abyss project", and that was how three Lithuanians and an Irishman found themselves on the August 2008 Ukrainian expedition to Krubera-Voronja.

Figure 1.2: 2008 "Call of the Abyss" Expedition to Krubera-Voronja



Our main task of that first expedition was to install water level loggers at depths of -1,710m (Chamber of Soviet Spelaeologists) and -1,810m in the main branch. The thing about installing loggers is you have to go back again to download them ... and so the 2009 expedition was happening whether we liked it or not!

The talk at the 2008 SUICRO symposium had raised interest, and Tony Furnell was soon on board for the 2009 August expedition. This time, the expedition had more independence from the Ukrainian team, although we worked closely with them under the same "Call of the Abyss" banner. Our team consisted of cavers from four different countries, and the expedition was named "Towards the Centre of the Earth". It was centrally organised by Aenigma Caving Club, and coincided with the millennial celebrations of Lithuania.

2. Expedition Aims and Objectives

We set out the following objectives before leaving for Abkhazia in 2009. Most were met.

	Aims/Objectives (from grant application) Comments							
1.		th -2,080 m and resurface safely	Successful					
1.	1.1		- Several ropes replaced.					
	1.1	Rig/rerig cave as necessary Transport food and camping gear to establish	- 5x underground camps were					
	1.2							
		staged underground camps (at least 3x	established, deepest at -1,810m.					
	1 2	mobile camps, deepest at -1,810 m)	12 savers passed sump					
	1.3	Pass free-diveable sump at -1,450 m	- 12 cavers passed sump.					
	1.4	Repair cabling and set up telephones to	- Cable repaired at -300m; phones					
	4 -	-1,790 m	worked to -1,900m					
	1.5	Reach -2,080 m (2 teams out of 4,	- 10 cavers reached -2,080 m; 3 of					
	4.0	approximately 10 cavers)	these reached -2,140 m					
	1.6	Resurface, removing all camping equipment	- Resurfaced in line with schedule,					
		and rubbish (including from previous	all removed all of our rubbish &					
		expeditions)	some from previous teams					
2.		tor water levels to determine flooding patterns	Successful					
	2.1	Retrieve & analyse data from water level	- Successful download and					
		loggers at -1,710 and -1,800 m (from last	analysis of 32,000 data points					
	0.0	year's expedition)	16 (000)					
	2.2	Clear level logger memory to start logging	- Loggers reprogrammed for 100%					
		afresh for 2009	more sample points next year					
	2.3	Install new level logger & ambient pressure	- New logger installed at -2,140m;					
		logger at -2,000 m	old logger moved to -1,900m					
3.		"Kvitochka" sump at -1,900 m	Successful					
	3.1	Support 2 divers in Kvitochka sump (water	- 3 divers passed Kvitochka and					
		levels permitting)	reached Dva Kapitana sump					
4.		ore inlet at -1,340 m	Successful					
	4.1	Continue bolting aven from last year's	- 2 new avens discovered, leads					
		expedition	ongoing					
	4.2	Survey new passage found	- Survey completed, length 126m					
5.		nine insect life	Successful (modified objectives)					
	5.1	Sample flying insects found at -1,800 m	- Suitable insect specimens not					
		during last expedition & transport to surface	available; but identified a known					
		for identification	troglobitic pseudoscorpion					
6.		ograph cave	Successful					
	6.1	Photograph as much underground as	- Got photos and video footage of					
		possible	camp & caving, down to -2,140m					
7.		onal development	Successful					
	7.1	Develop expedition & planning skills by	- Both Irish members were integral					
		partaking in a 3-week, large-scale,	part of planning & execution of					
		international expedition to a remote area	expedition					
	7.2	Develop caving skills – in particular	- Irish members spent 10-11 days					
		underground self-sufficiency & confidence –	underground, including solo					
		and attain personal depth record (and Irish	caving. Depth records for both					
		depth record)	(-2,080m).					
8.	Gath	er information for future Irish expeditions	Partly successful					
	8.1	Make firm contacts with Lithuanian,	- Links established; 2010					
		Ukrainian, Russian, Hungarian & Spanish	expedition planning with same					
		cavers	group underway					
	8.2	Search neighbouring valley (relatively	- Not done – fog & lack of time					
		unexplored) for cave	meant search not possible					
	8.3	Prepare expedition report (English-language	- This report written; also photos,					
		accounts and descriptions are currently	video footage, presentations and					
		limited)	scientific research					
		,						

3. Location

Krubera-Voronja Cave, the current deepest explored cave on earth, is located near the Black Sea, in the Western Caucasus Mountains of Europe. It falls within the territory of Abkhazia, an effectively independent republic whose independence from Georgia is only recognised by a handful of countries worldwide including Russia.

Figure 3.1: Political Map, Europe



The cave entrance is found in the Orte-Balagan valley of the Arabika Massif, in the Gagra mountain range.

The Arabika Massif is one of the largest high-level karst massifs in the western Caucasus, bordered by the Bzyb gorge to the east and the Black Sea to the west. Its valleys lie at 2,000-2,300 metres, while peaks rise to 2,500-2,700 metres. The only entrance to the Krubera-Voronja cave system is at an elevation of 2,256 metres.

Figure 3.2: Orte-Balagan Valley, Arabika Massif



Figure 3.3: Caucasus Region (Abkhazia Circled)

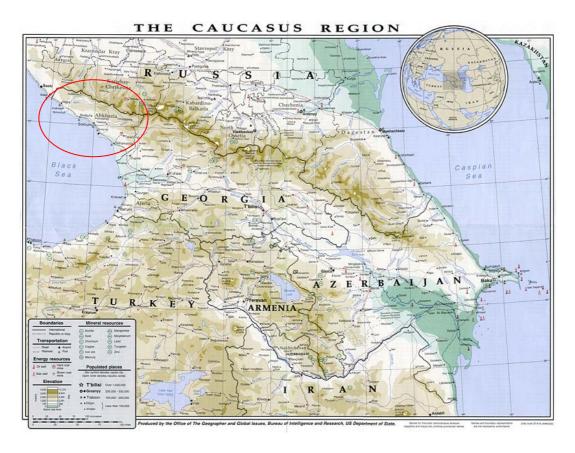
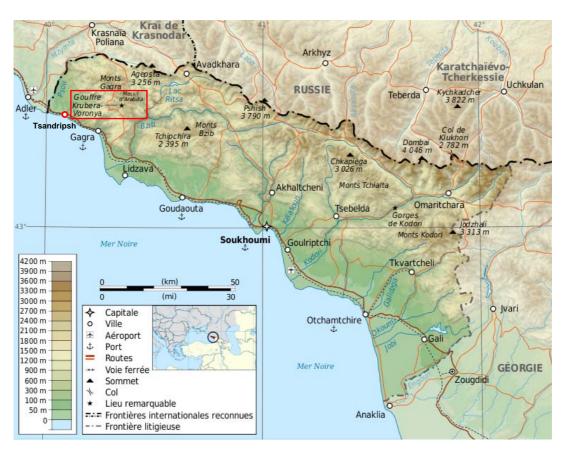


Figure 3.4: Abkhazia



The closest village to the cave is Tsandripsh, a small resort on the coast of the Black Sea, some 6 hours' drive away through mountain roads. This was where the international team assembled at the start of the expedition.

It is possible to find hostel or guest house accommodation in Tsandripsh, which is geared up for the Russian/Abkhazi tourist market. English-speaking tourists aren't common here - or indeed anywhere in Abkhazia, so it is advisable to have a Russian speaker with you.

There are plenty of restaurants, food markets and small shops in Tsandripsh, and a dilapidated train station and stretch of beach. You won't find much more than this - there are no bank machines or tourist information centres for example.



Figure 3.5: Tsandripsh Station (with Abkhazian Flag Flying)



Politics

The Abkhazian Republic is a breakaway republic from the former Soviet State of Georgia. It gained control of the territory after the war of 1992-1993 between Georgian forces and Abkhazi separatists. Since this time, it has had strong control of the area. The republic is not recognised by Georgia, Western Europe or most of the wider international community. However, it enjoys support from Russia, who in August 2008 officially recognised its independence.

The status of breakaway regions of Abkhazia and South Ossetia have been an ongoing source of tension between Georgia and Russia, contributing to frequent clashes including the most recent military conflict in 2008.

The politics of the region does impact upon caving expeditions – access to the territory is effectively limited to two, land-border crossings, and it is necessary to obtain a visa from the Abkhazian Ministry of Foreign Affairs. Political conflict halted caving exploration in the area for a large part of the 1990s, and the 2008 summer expedition was almost prevented due to the Russian/ Georgian conflict.

Figure 3.6: Abkhazia and South Ossetia



4. Geology and Hydrology

Much work in the area of geological and water tracing surveys have been conducted by Ukrainian spelaeologists, lead mainly by Alexandar Klimchouk and Yuri Kasjan. Papers on the geology and hydrology of the Arabika region and Krubera-Voronja Cave are available online (see References).

The following diagrams and summary are drawn directly from these sources.

The Arabika Massif is one of the largest high-mountain limestone karst massifs in the Western Caucasus. It is composed of Lower Cretaceous and Upper Jurassic limestones that dip continuously southwest to the Black Sea and plunge below the modern sea level. Among several hundred caves known in the Arabika Massif, fifteen have been explored deeper than 400 m and five deeper than 1,000 m.

Krubera Cave is located at 2,256 m altitude in the Ortobalagan Valley. All large caves of the Ortobalagan Valley likely belong to a single hydrological system, connected to large springs at the Black Sea shore.

The Ortobalagan Valley extends along the crest of the Berchil'sky anticline, which gently dips northwest. The cave entrances are aligned along the anticlinal crest (see Figure 4.1) but the caves are controlled by longitudinal, transverse, and oblique fractures and faults and comprise complex winding patterns in the plan view, remaining largely within and near the anticlinal crest zone. The caves are predominantly combinations of vadose shafts and steep meandering passages, although in places they cut apparently old fossil passages at different levels.

Krubera Cave has an extremely steep profile and reveals a huge thickness of the vadose zone. The lower boundary of the vadose zone (the top of the phreatic zone) is at an elevation of about 110 m at low flow, which suggests a low overall hydraulic gradient of 0.007-0.008. Low total dissolved solids groundwater is tapped by boreholes in the shore area at depths of 40-280, 500, 1,750, and 2,250 m below sea level, which suggests the existence of a deep flow system with vigorous flow. Submarine discharge along the Arabika coast is reported at depths up to ~400 m below sea level.

It is difficult to interpret these facts in terms of the development of karst systems controlled by contemporary sea level, or within the range of its Pleistocene fluctuations (up to -150 m). In combination with the existence of the Arabika Submarine Depression, all these facts point to the possibility that karst systems in Arabika could have originated in response to the Messinian salinity crisis (5.96-5.33 million years ago) when the Black Sea could have almost dried up, as did the adjacent Mediterranean, where the dramatic sea level drop of ~1,500 m is well established.

Arabika Massif West Caucasus, Abkhasia (Georgia) Speleo-hydrologic map egsky Vodopad Degnari D Alexander Klimchouk, 2001 Gantiadi 3 BLACIK SIEA ioluboje Czeg Legend: Mein ridges Walls and stoop slopes Mountain tops and their abitudes BZYBSKY o Tsivi-Takaro . rn Deep caves and their depths Springs, <300 l/s grat Takwebi Springs, >300 l/s Hydrogeologic connections between cave streams and major springs confirmed by dye tracing tests Submarine springs Water-yeldings borel SCHEMATIC PROPILE SW-NE ARABIKA Large resurgences on the shore 1000

Figure 4.1: Hydrological Map of Arabika Massif (Krubera-Voronja shown as -1,710)

Figure 4.2: Section of Krubera-Voronja Cave

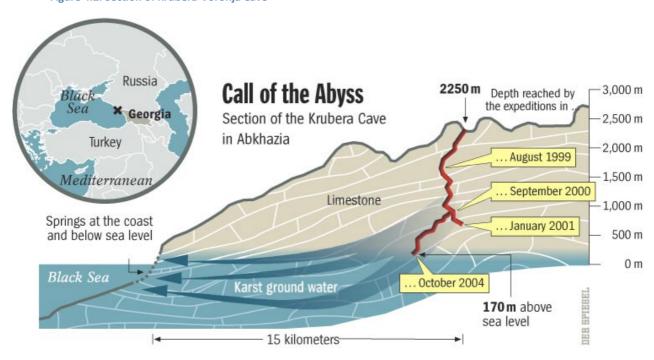
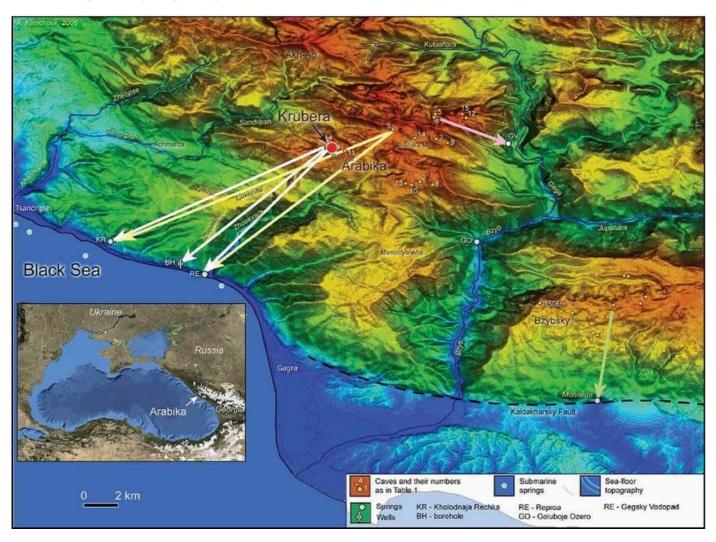


Figure 4.3: Hydrological Map of Arabika Massif



5. Cave Description

Times are estimated with 2 bags in tow.

Entrance to -700m 4 hours

The entrance to Krubera-Voronja is an unassuming, 1-metre-wide, 4-metre-long cleft on the side of a hill in the Ortobalagan Valley. The pitch quickly opens out and after some rebelays reaches the rock-strewn floor 57m below. The rubble is from frost shattering at the entrance, and continues for some distance down the small tube leading off from the foot of the rope.

Figure 5.2: Entrance Pitch



Figure 5.1: Entrance

A couple of short drops bring you to the top of the 115m shaft, which soars down with about 4 rebelays. The pitch – like all of the big shafts down to –1,200m – is impressive in its magnitude. You quickly reach the 43m pitch, of which you descend only 7m before swinging into a walking-sized tube in the wall – "Krym". This is the "magic window" that was known about since the mid-eighties but only entered in 1999, and which led to the

flurry of exploration that in 2 years transformed a 340m pot into the deepest cave in the world.

Continuing further down the 43m pitch the tight meander to the "Nekujbyshevskaja" branch is found (so called because despite speculation, it has not been linked with Kujbyshevskaja Cave).

Krym has a howling gale and quickly opens up to the vast blackness of the

Figure 5.3: Krym Connection



Sinusoida is not very tight, and not all that long for that matter – but again carrying bags makes it a chore. There are some pitches along the way, and most of it is travelled at the base of the meander. A small stream gradually forms as tributaries enter. One of these is Lamprechstofen,

which enters from the left just

meander. A couple of pitches open to the 71m pitch – a beautiful drop with takes you

before the end of the

110m pitch. There is spray in

normal conditions at the bottom of the pitch. Meander Mozambique is short and easy-going (though annoying with bags). Afterwards, the huge 152m pitch, via a couple of big ledges, takes you to the 500m mark and the start of the

Sinusoida Meander.

Figure 5.4: Sinusoida Meander

to the homely sight of Camp -700.

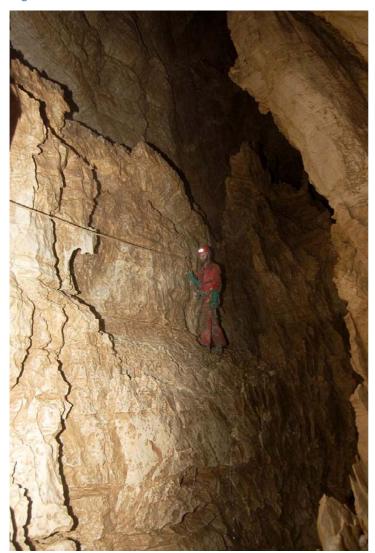
-700 to -1,400m

7 hours

The tent is pitched at the back of the chamber, on a large slab with drops on 2 sides. Down a hole at the back of the tent, a tube leads to a wet section and an awkward take-off. This part of the cave is much wetter than the upper section, with plenty of active cascades, although the bolting goes a long way to keeping you mostly dry. The rigging standard is excellent in fact throughout the cave – even at the very bottom: textbook rebelays to avoid rub points and hazards.



Figure 5.5: Traverse in 700-1400 Section



Camp -1,200 is on a muddy platform at the foot of another 71m shaft and is a respite from the water. We only camped there during the exit from the cave. Beyond, another very wet and active cascade section follows. It includes a tight take-off past a water spout which is difficult to avoid. However, near the bottom of this pitch, a pendulum brings you into a dry tube. Looking across from the tube through the spray, a passage on the other side carries the water away to -1,410m, and also leads to the "Spanish Branch" where bolting efforts are ongoing.

The dry tube takes you into the comfort and relative warmth of a parallel set of dry pitches which are remarkably quiet in comparison. You will probably hear the roar of a Primus stove before

you reach the top of the 23m pitch, which would drop you straight through the ceiling of Camp -1,400 were it not for a last-minute deviation. This is an atmospheric place – a mushroom-tunnel type tent on a flat floor with room for ten cavers. Its name is "Sandy Beach".

-1,400 to -1,710m ("Chamber of Soviet Spelaeologists")

3 hours

A small way up the slope from Camp -1,400, a hole through boulders continues to a pitch. A tight rift (two alternate routes, one tighter than the other!) from the bottom of the pitch leads to a further, 12m pitch. This can be traversed across, and the passage soon opens up.

There are several easy and spacious pitches before the final spectacular waterfall, which cascades 34m down into a pretty green pool (a tensioned line allows you to avoid wetting your feet). Adjacent to the pool is the Chamber of Soviet Spelaeologists, a large chamber with a boulder floor, which when discovered in 2001 created a new world depth record.

Figure 5.6: Ascending from Chamber of Soviet Spelaeologists



-1,400 to -1,640m 3 hours

Descending the 12m pitch leads to a tube and a sump (Sump 1). This is about 1.5m long, 1m in diameter, and shallow (ceiling submerged by about 10cm). It can be free-dived using the in-situ rope. Beyond this, the cave develops into wet cascades in nicely sculpted rock. It's a very sporting bit of cave with ducks. Camp -1,640 is at the bottom of a dry oxbow pitch.

-1,640 to -1,800m 3 hours

Beyond the camp, the stream is soon found again, and the passage can be continued to a sump at -1,785m. However, by entering a window 2m high just downstream of the camp, "Way to the Dream" is found. This small dry passage continues past

several little pitches to reach the "Yellow Tube", a flat-out 130m crawl. While not hugely constricted, with bags it is a torture. The floor is calcite so is easy to slide along. In this section, you really will feel that you are in the bowels of the earth.

At the end, a hole through the calcite floor pops out to the head of a pitch. and after this the cave suddenly opens up. Passage is very pleasant here with glossy black limestone, walking dimensions and plenty of formations in comparison to

Figure 5.7: The "Yellow Tube"



other parts of the cave. Camp -1,800 is a small rocky platform just beside the "Big Junction", which is a confusing network of passages.

-1,800 to -2,080m ("Game Over")

2 hours

The way through the Big Junction is to traverse across the drop towards the obvious continuation (traverse line in place). Following the main passage brings you to a 25m pitch and then a hole in the floor which takes the stream. Down this hole and another pitch is Kvitochka Sump and the divers' route to the cave's deepest point, Dva Kapitana Sump (currently -2.191m).

Stepping over the hole towards the ongoing horizontal passage leads to Camp -1,900. The passage can be followed past more pitches – including the "Millenium" 40m pitch – until it eventually drops into a large, tubular passage which is half filled with mud. The cave character changes abruptly here from its previously vertical nature to being predominantly horizontal. Crawling or crouching along the flat floor leads after 100m to the final chamber, "Game Over", where the world depth record was made in 2004 and held for nine months until it was beaten by exploration beyond Kvitochka Sump.

Figure 5.8: "Game Over", -2,080m (Tony, Gema, Marci, Lajos, Paulius (front), Stephen, photo by Kutya



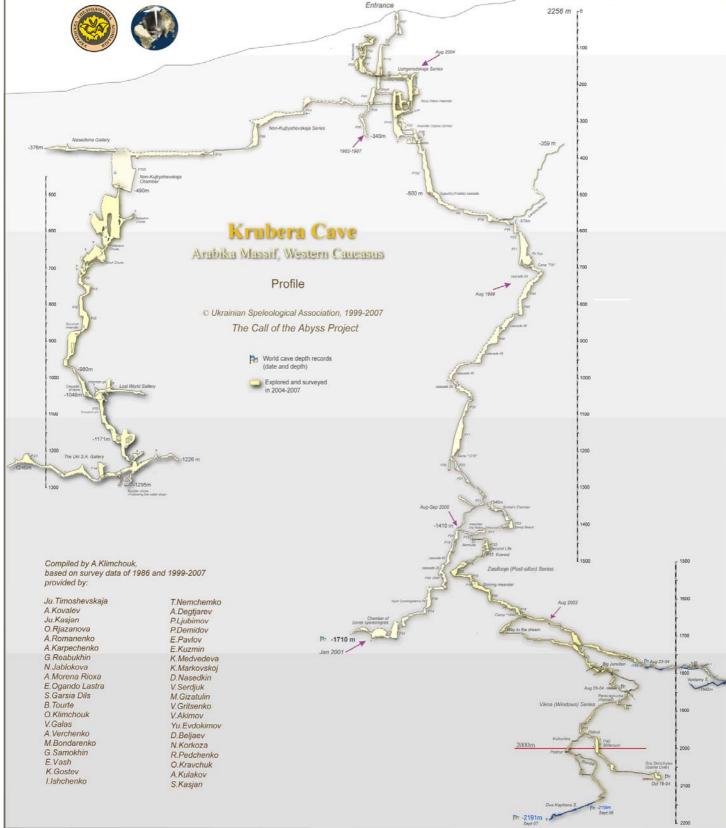
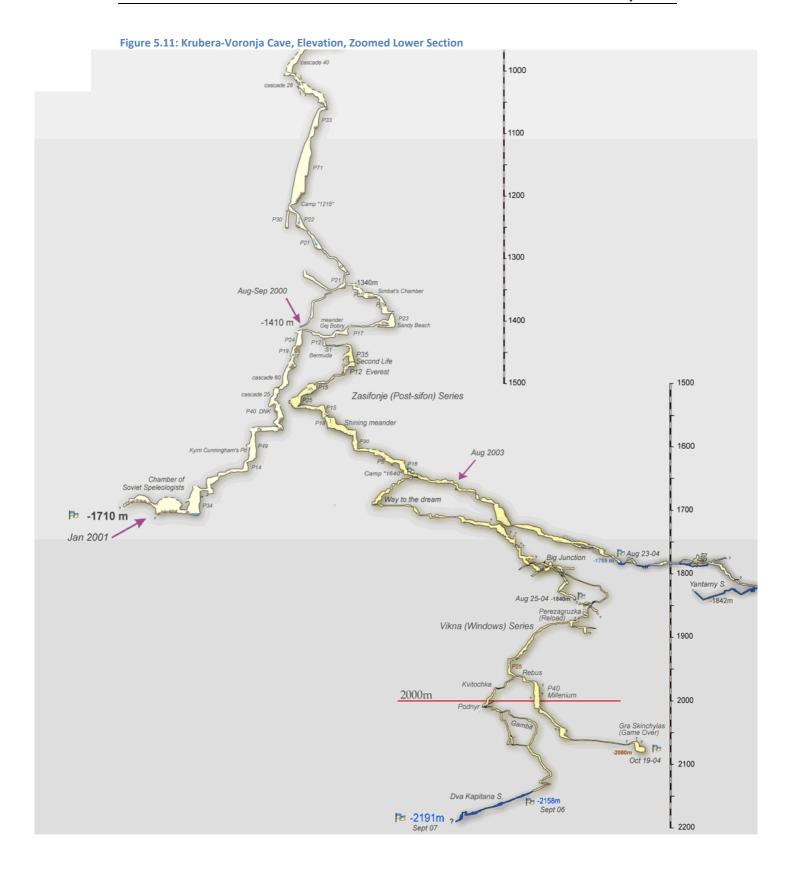


Figure 5.10: Krubera-Voronja Cave, Plan © Ukrainian Speleological Association, 1999-2007 The Call of the Abyss Project Krubera Cave Arabika Massif, Western Caucasus Plan 100m Non-Kujbyshevskaja Series World cave depth records (date and depth) Explored and surveyed in 2004-2007 Compiled by A.Klimchouk, based on survey data of 1986 and 1999-2007 provided by: provided by:
Ju. Timoshevskaja
A. Kovalev
Ju. Kasjan
O. Rjazanova
A. Romanenko
A. Karpechenko
G. Reabukhin
N. Jabiokova
A. Morena Rioxa
E. Ogando Lastra
S. Garsia Dils
B. Tourte
O. Klimchouk
V. Galas
A. Verchenko
M. Bondarenko
G. Samokhin
E. Vash
K. Gostev
I. Ishchenko A. Degljarev P. Ljubimov P. Demidov E. Pavlov E. Ravlov E. Kuzmin K. Medwedeva K. Markovskoj D. Nasedkin V. Serijuk M. Gizatulin V. Gritsenko V. Akimov Yu. Evdokimov D. Beljaev N. Korkoza R. Pedchenko O. Kravchuk A. Kulakov S. Kasjan -1410m **1**-2191m Vikna (Windows) Series



6. History of Exploration

The first exploration of Krubera-Voronja Cave began in the early 1960s, but it was not until 2004 that the magic 2,000 metre depth had been reached. Exploration is continuing to date.

See the survey on the next page for colour key.

Early 1960s	Georgian cavers first explore the entrance shaft and name it Krubera Cave after famous Russian karst scientist Alexander Kruber (1871-1941). Stopped by squeeze in meanders at bottom of shaft, -95m
1960s, 1970s	Cave neglected apart from occasional visits from various clubs
1980	Kiev Speleological Club with Alexandar Klimchouk starts systematic exploration/digging in Ortobalagan Valley
1982	Kiev cavers start working in Krubera with the aim of linking to Kujbyshevskaja Cave (200m distant) and the Arabikskaja System, and adding 60m depth to the Arabikskaja System
1982- 1987	Slow progress through tight meanders requiring blasting; cave deepened to – 340m. Two windows at depths of 220-250m is marked on survey but unexplored. Cave is christened "Voronja" (Воронья – Crows') Cave because of crows nesting in entrance.
1988- 1998	Political instability; war during 1992-1994; caving largely suspended
1999	Ukrainian Spelaeological Association (Ukr.S.A.) explores two windows at depths of 220-250m. Main branch is pushed to -740m and "Nekujbyshevskaja" branch pushed to -500m.
2000	 August – Ukr.S.A. pushes main branch to -1,200m. September – Ukr.S.A. pushes main branch to -1,410m
2001	January – Ukr.S.A. pushes main branch to -1,710m ("Chamber of Soviet Spelaeologists" - world record) "Call of the Abyss" project is established, coordinated by A. Klimchouk, Y. Kasjan, G. Samokhin and K. Markovskoy. Its aim is to find the first 2,000m deep cave, focussing on Turkey and Abkhazia.
2003	Kiev Spelaeological Club and CAVEX pass Sump 1 at -1,440m and continue to -1,660m
2004	July – CAVEX continue to -1,775m beyond Sump 1. August – Ukr.S.A. discover "Way to the Dream" passage and push to -1,840m October – Ukr.S.A. discover new lead near Big Junction at -1,790m and push to -2,080m ("Game Over") – first achievement of 2km depth
2005	February – Ukr.S.A. pass "Kvitochka" sump at -1,980m July – CAVEX explore beyond "Kvitochka" to -2,140m August – Ukr.S.A. extend "Nekujbyshevskaja" to –640m
2006	Ukr.S.A. dive "Dva Kapitana" sump to -2,158m Ukr.S.A. extend NK to -1,004m
2007	Ukr.S.A. dive "Dva Kapitana" sump to -2,191m. Ukr.S.A. dive "Blue Lake" sump and extend side passage -1,841m Ukr.S.A. extend NK to -1,293m
2008	Ukr.S.A. extend NK to -1,390m Lithuanian/Irish commence hydrological monitoring in main branch and bolting "Spanish Branch" at -1,340m
2009	Ukr.S.A. extend NK to sump at –1,557m "Towards the Centre of the Earth" expedition continues monitoring in main branch and extends "Spanish Branch"

2256 m Krubera Cave Arabika Massif, Western Caucasus Profile O Ukrainian Speleological Association, 1999-2007 The Call of the Abyss Project World cave depth records (date and depth) Explored and surveyed in 2004-2007 Compiled by A.Klimchouk, based on survey data of 1986 and 1999-2007 provided by: Ju.Timoshevskaja A.Kovalev Ju.Kasjan O.Rjazanova A.Romanenko A.Karpechenko G.Reabukhin N.Jablokova A.Morena Rioxa E.Ogando Lastra S.Garsia Dis B.Tourte T.Nemchemko A.Degtjarev P.Ljubimov P.Demidov E.Pavlov E.Kuzmin K.Medvedeva K.Markovskoj D.Nasedkin V.Serdjuk M.Gizatulin V.Gritsenko T.Nemchemko 70 -1710 m B.Tourte O.Klimchouk V. Gritsenko V. Akimov Yu. Evdokimov V. Galas A. Verchenko M. Bondarenko G. Samokhin D.Beljaev N.Korkoza R.Pedchenko O.Kravchuk E.Vash K.Gostev A.Kulakov S.Kasjan I.Ishchenko

Figure 6.1: Krubera-Voronja Cave, History of Exploration

7. Expedition Team

The 2009 "Towards the Centre of the Earth" expedition comprised 20 cavers from four countries. The expedition leader was Aidas Gudaitis, from Lithuania.

Country	Number of Cavers	Club
Lithuania	12	Aenigma – <u>www.speleo.lt</u>
Ireland	2	Shannon Group – sites.google.com/site/shannoncavegroup/
Spain	2	GAEM – www.espeleogaem.org/
Hungary	4	MAFC Speleo Club – <u>barlang.hu/mafc/</u>
Total	20	

Figure 7.1: Expedition Members, Last Day of Mountain Camping



		Egis	Stephen	Violeta	Lina	Gintarė	Tony Aidas	
Paulius	Vilma	Jesús Tučkus	Gedas Gema	Pedro Nerius	Jurga Donatas		Kutya	Lajos Marci

Our expedition was part of the larger project "Call of the Abyss", which included another team of approximately 25 cavers from the Ukraine, Russia, Moldova, Bulgaria and Israel, headed by Yury Kasjan of the Ukrainian S.A.

We cooperated closely with the other team as they were camping beside us on the surface, and also inside the cave with us at the same time albeit in a different location. Their aim was to extend the "Non-Kujbyshevskaya" Branch of the cave, while we were working within the main route. Apart from this high-level cooperation, the occasional radio contact underground, and the requisite post-expedition joint festivities, the two expeditions continued independently.

Within our group, we had four separate caving teams. The common language was fortunately English. There were a few small understanding difficulties but nothing unsurpassable! After the first part of the descent, three of the teams met at the main camp at -1,400 metres. From this point onwards there was some reorganisation as plans were tweaked depending on the situations that arose – e.g. sickness, temporary loss of radio communication, personal preferences, etc.

Name	Country	Name	Country	
Aidas Gudaitis		Paulius Dambrauskas	Lithuania	
Egidijus Purlys (Egis)		Vilma Bledaitė	Littiuariia	
Violeta Bladžiūnaitė		Stephen Macnamara	Ireland	
Lina Liuberskytė		Tony Furnell	ireianu	
Gintarė Šiaulytė	Lithuania	Pedro Jiminez	Spain	
Gediminas Sakalauskas		Jesús Martinez		
Jurgita Pekorienė (Jurga)		Márton Kucsera (Marci)	- Hungary	
Donatas Pekorius		Zsolt Németh (Kutya)		
Artūras Artiušenka (Tučkus)		Lajos Sass		
Nerijus Štreimikis		József Zih (Gema)		

8. Expedition Timeline

Mon 10th August

- TF flights: Dublin-Amsterdam, Amsterdam-Moscow, Moscow-Adler
- TF bus to Psou, cross Russian border on foot, bus to Tsandripsh

Tue 11th August

- 12.30am (GET) TF arrival at guesthouse in Tsandripsh
- SM flights Dublin-Amsterdam, Amsterdam-Moscow, Moscow-Adler
- SM bus to Psou, cross Russian border on foot, train to Tsandripsh
- Abkhazian visas obtained from Sukhumi
- Preparation of equipment/food bags
- 10pm SM arrival at guesthouse in Tsandripsh

Wed 12th August

- Final preparations
- · Arrival and packing of hired trucks
- 6 hour truck journey from Tsandripsh to the Arabika
- Unpacking and departure of trucks
- 1 hour trek to camping base
- Surface camp setup

Thu 13th August

- Relaying equipment from truck dropoff to surface camp
- Establishing connection to cave/surface radio system
- · Repacking food bags for cave purposes

Fri 14th – Thu 27th August

Caving

Fri 28th August

• SM departure from Arabika, 6 hour truck journey to Tsandripsh

Sat 29th August

- Further caving to retrieve remaining supply bags from Voronja cave
- Relaying equipment to truck pickup point
- SM travel across border, departure from Adler, flights Adler-Moscow, Moscow-Amsterdam, Amsterdam-Dublin

Sun 30th August

- Break surface camp
- Relaying equipment to truck pickup point
- TF 6 hour truck journey to Tsandripsh
- Unpack trucks

Mon 31st August

Rest & relaxation

Tue 1st September

• 11pm TF departure from Tsandripsh

Wed 2nd September

 TF travel across border, departure from Adler, flights Adler-Moscow, Moscow-Amsterdam, Amsterdam-Dublin

9. Surface Camping

Location:

The surface camp of the *Towards the Centre of the Earth* expedition was located on a plateau 10 minutes' walk from the Voronja entrance. Half way between us and the cave lay the larger Ukrainian *Call of the Abyss* camp.

Figure 9.1: Front left: Call of the Abyss camp; back right: Towards the Centre of the Earth camp. Taken from Voronja entrance. Photo: Tony Furnell



Communal areas:

We pitched a central mess tent, surrounded by personal tents wherever flat ground could be found. A small petrol generator had been brought along to provide light and charging facilities in the mess tent; seating and table space was provided by rocks retrieved nearby.

Figure 9.2: Towards the Centre of the Earth surface camp. Photo: Artūras Artiušenka



Food and water:

All of our food had been brought up from Tsandripsh on the trucks (the vast majority having come directly from Lithuania).

There are no surface streams in the valley, and we had brought a small amount of personal water supply for the journey. For the rest of the expedition we were to rely on melted snow. Snowdrifts lay in some of the nearby depressions, and a daily task was to shovel snow into bags and bringing it back to the camp.

Figure 9.3: Gediminas Sakalauskas and Aidas Gudaitis shovel snow. Photo: Tony Furnell



Beside the camp, a snow melting system was set up with two tarps draining into a barrel; snow shovelled between the tarps would slowly melt and trickle into the barrel after a few hours in the sunlight.

Figure 9.4: Snow melt system. Photo: Tony Furnell



Water from snow melt had to be boiled before use; as a result there was relatively little cold water available to drink, and tea was often made from the group rations or from herbs and flowers growing in abundance around the camp.

All expedition members were responsible for food preparation, although those less active underground were naturally on food duty more often. The food organisation on the expedition was excellent; ingredients were well thought out and abundant in supply; each meal was generally a combination of:

- tinned meat/fish or preserved sausage
- fresh root vegetables, salads or tinned vegetables
- rice, pasta or instant mashed potato
- flavouring provided by packet soups, herbs, salt, mayonnaise and/or ketchup.

Additional supplies included bread and cheeses, and occasionally expedition members would trek down the valley to the nearest farmer's house (a 3-hour round trip) and buy fresh cheese and other produce.

Cooperation with other expeditions:

With the *Call of the Abyss* camp site in such close proximity, it was important to maintain good relations with the other cavers. Many of their members had already caved with members of the Lithuanian expedition, and two dinners were organised at the start and at the end of the trip; food was supplied in the first case by the Ukrainian group, and in the second by ourselves.

Figure 9.5: End of expedition feast in *Call of the Abyss* camp. Photo: Tony Furnell





Figure 9.6: Caving helmets: also useful for food preparation. Photo: Jesús Martínez Sánchez

Toilet facilities:

There were two or three regular toilet locations near the expedition surface camps, all within 5 minutes' walk of the communal areas. These were generally small dolines that had previously been investigated for cave sites and found to have no prospects. Any paper waste was burned after use, and the toilet areas themselves were also used as bonfire sites at the end of the trip, when any flammable waste was burned to save weight on the return.

10. Underground Camping & Food

List of camp sites in Voronja Cave: (excluding Non-Kujbeshevska branch)

Camp sites were located at strategic points along the route of the cave. The first four sites had a tarpaulin roof in situ, under which we would pitch our tent for the night.

Each site was close to a running water source, as well as a specified dry toilet area.

- -700 m:
 - small site, max 5 persons (1 tent)
 - · tarp roof in place
 - · tent pitched on flat rock
 - · radio connection point
- -1215 m:
 - large site, max 8 persons (1 large tent)
 - · tarp roof in place
 - · pitched on flattened area of sand
 - radio connection point
- -1410 m:
 - large site, max 10 persons (1 large permanent tent, additional tent +3/4 persons)
 - permanent tent pitched on flattened sand mound
 - · tarp roof in place
 - additional space for temporary tent to be pitched
 - radio connection point
- -1640 m:
 - max 5 persons (1 tent)
 - · tent pitched on flat sand
 - · tarp roof in place
 - radio connection point
- -1800 m:
 - max 5 persons (1 tent)
 - · tent pitched on flat sand
 - · radio connection point
- -1960 m: (not used on this expedition)
 - max 5 persons (1 tent)
 - tent pitched on sharp rocks
 - radio connection point



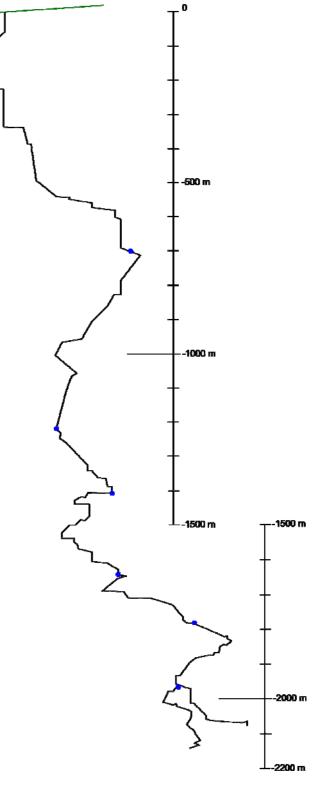


Figure 10.2: Pedro Jiménez Rodríguez outside an additional tent at Camp 1410. Photo: Jesús Martínez Sánchez

Tents underground:

The preferred choice of tent for this expedition was made from parachute silk, making it very light and partially breathable. The expedition had four of these tents at its disposal, so unless otherwise planned, groups would carry a tent with them to pitch at the next site, then take it down again after resting.

Tarpaulins had been left in situ by previous expeditions at four sites that were prone to being dripped upon, under which the parachute tents could be hung, providing walls and an inner roof to keep warmth inside.

All cooking, planning and resting was done inside the tents as the ambient temperature outside was too low for comfort (generally around 5 degrees Centigrade or less). Cooking inside the tents helped to build up

warmth, although it also meant that humidity was often high, and tents had to be pitched carefully to avoid discomfort from condensation.



Figure 10.3: Camp 1410; foreground: permanent tent and background: additional tent. Photo: *Jesús Martínez Sánchez*



Food underground:

A large portion of the bags carried through the cave contained food. The bags were packed in a system whereby one bag would feed one team of 4-5 people

for one day. All bags were then packed with the same amount of food, drink and condiments.

Typically, each bag would contain:

4x bags of pasta, rice or noodles	2x portions of ketchup
3x preserved sausages	1x block of cheese
5x packets of soup	2x squeezy tubes of condensed milk
1x box of dried Lithuanian black bread	1x portion of salt
2x packets of sweets	1x portion of dried vegetables
2x packets of biscuits	10x sachets of coffee
1x portion of mayonnaise	10x teabags

Food supplies were more than ample; it also allowed for relatively varied meals, which are quite difficult to achieve in this situation.

Figure 10.4: Gintarė Šiaulytė eating in underground camp. Picture: Artūras Artiušenka



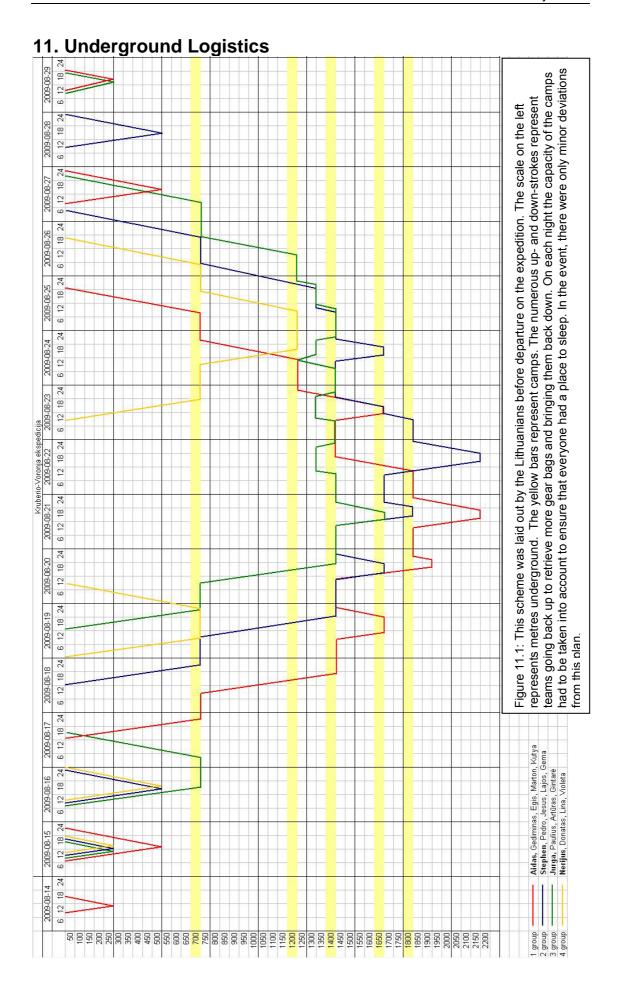


Figure 10.5: Dining at camp 1410. Photo: Jesús Martínez Sánchez

Sleeping and waking:

With cavers staying underground for anything from 4 1o 11 days, the only indicators of day and night were our personal watches. In long trips such as these it is possible (even natural) to extend days further than they would normally be on the surface, and to sleep longer, so that one waking/sleeping cycle underground could last 36-48 hours. For the majority of the trip, we chose to stick close to standard day and night times, to allow us to keep to the planned logistics and to more easily stay in contact with those on the surface.

The exception to this came on the way out, when it was less important to be on the same clock as everyone else for rendezvous purposes, and more desirable to use whatever time was available to keep moving out of the cave. As a result our group spent the last two days working in 8-10 hour cycles of movement and resting.



12. Communications

At our disposal during the expedition were the Ukrainian Speleological Association self-built radios, developed by Leonid Fegin (Israel).





The system worked by running a cable through the cave, bared for connection at certain communication points (namely the camp sites). The cable was attached to one terminal of the radio, with the second terminal routed to earth. The system was powered from a central module at the Ukrainian surface camp.

Figure 12.2: Paulius Dambrauskas using the radio in underground camp. Photo: Violeta Bladžiūnaitė



Communications failure

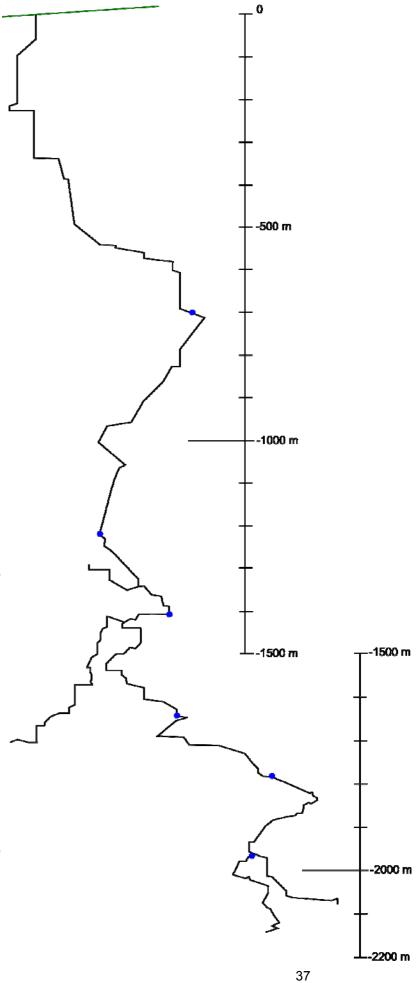
When fully functional, communication was clear as a bell, even to the lowest point where we had a connection, -1980 m.

Unfortunately, at one point 2 days into the trip, we lost communication with the surface. At the time, group 1 were at Camp 1410, waiting to go through the free-diveable sump at -1450 m. We were expecting to check that there had been no change in the weather on the surface before doing so, as little is still known about the speed of hydrological reactions in the cave.

Over the course of a few hours we worked out that we could communicate with Lithuanian groups at -1215 m and -700 m, and even with Ukrainian groups in the Non-Kujbeshevska section of the cave (a branch which begins at around -200 m and currently descends to around -1400 m) in Russian. We deduced then that there must be a break in the connection in the first 200 m of the cave's depth.

Having waited the best part of a day at Camp 1400, the initial group that would head through the sump and check rigging for the next 200 m down to Camp 1640 made the decision to push on. Nothing had changed at the sump during this time.

Eventually, communications were not regained until 2 days afterwards, when we reached Camp 1800 ("Big Junction"). The surface cavers had worked out the problem the same as we had, and had sent cavers down from the surface to check and repair the cable.



13. Personal Kit

As usual, baggage weight had to be taken into account while assembling gear in Ireland, both to be certain that we could carry everything ourselves and to avoid any issues with our flight providers. As a result, everything was cut down to exactly what we could manage with for the four-week period. This still meant some very careful planning with regards to clothing, as the weather was to be hot and sunny for the journey and by the coast in Abkhazia, but changeable and potentially very cold and/or wet in the mountains.

Surface kit:

- Tent (1x 2-man tent between us)
- 2x sets of clothes
- 1x set of thermals
- Sleeping bag
- · Sleeping mat
- Sun hat
- Swimming shorts (for our time at Tsandripsh)
- Towel
- Toiletries (minimal)
- Sun cream
- Bowl, cup, cutlery
- Camera (optional)
- Knife etc. (optional)

Underground kit:

- Helmet and light (inc. batteries to last 14 days)
- Spare light (inc. batteries to last at least 3 days)
- Undersuit
- Oversuit
- Wellies
- 2x pairs gloves
- Kneepads (optional)
- Sleeping bag (lightweight synthetic)
- 1x set of thermals (or second undersuit) for sleeping
- Socks for sleeping
- Socks for caving
- Balaclava for sleeping
- Balaclava for caving (optional)
- Drysuit and neoprene hood (for diving sump at -1440)
- Drybag (preferably 2-3)
- Wrist watch
- First aid kit
- Knife and lighter
- Full SRT kit (inc. foot jammer)
- Spare top bobbin for Stop descender
- Spare chest jammer
- Spare krabs

Figure 13.1: Carrying gear down from campsite



Figure 13.2: Tony tries on his new drysuit Photo: Tony Furnell



Provided by the expedition were AA batteries (as a result many cavers were using Petzl Duo lights), sleeping mats for the cave, all cooking equipment and fuel, rigging hardware, underground tents and associated ropes, 1x large drybag each.

Specific kit:

In addition to the above, there was some kit required to fulfil the various aims of the trip, namely:

- Dataloggers: Solinst Levelogger and Barologger (packaged to be cave-safe)
- Cord and PVC tubing for installing data loggers in the cave
- Handheld datalogger computer interface
- Bolting kits (for bolting in Spanish Branch and installation of data loggers)
- Surveying equipment



Figure 13.3: Levelogger and computer interface on the surface. Photo: Jesús Martínez Sánchez

Kit failure:

Most of the ropes in use in the cave had been installed two years previously and had been in place for numerous expeditions already. As a result, many of them were highly gritty and particularly wearing on gear. On reaching Camp 1410 many descender bobbins were retired; thankfully the ropes beyond the sump were mostly clean-washed and not so wearing.

14. Hydrological Measurements

Background

Previous to 2008, the limited understanding of Krubera-Voronja's flooding patterns was based on anecdotal evidence, and some simple homemade flotation devices that showed peak water levels.

During the 2008 "Call of the Abyss" expedition, which included cavers from the Ukraine, Russia, Lithuania, Ireland and Israel, water level monitoring devices were placed for the first time into the system. The main purpose was to improve the safety and planning of future expeditions by finding out:

- how frequently and when during the year significant flooding occurred;
- how fast flood water rose and subsided.

2 water loggers were placed in the main branch, at -1,710 metres (Chamber of Soviet Spelaeologists) and at -1,806 metres (Big Junction).

The primary purpose of the 2009 expedition was to download the data from these 2 loggers and to place a further logger at the bottom of the cave.

Methodology and Equipment

The Spelaeological Union of Ireland and Waterra UK sponsored the purchase of monitoring equipment in 2009.

Manufacturer	Solinst	
Supplier	Waterra UK (www.waterrauk.com)	Solinst Levelogger®
Model	Levelogger Gold M100	Solinst Leve
Battery Life	10 years	. 300
Weight	179 g	
Capacity	40,000 pressure (depth) + 40,000 temperature readings	
Range	0-100 metres head of water	
Accuracy	±5 cm water; ±0.05°C	

Approximately 50 metres above each Levelogger, a logger for ambient pressure was also installed to allow correction of the Levelogger readings for fluctuations in atmospheric pressure. The model used was the Solinst Barologger Gold.

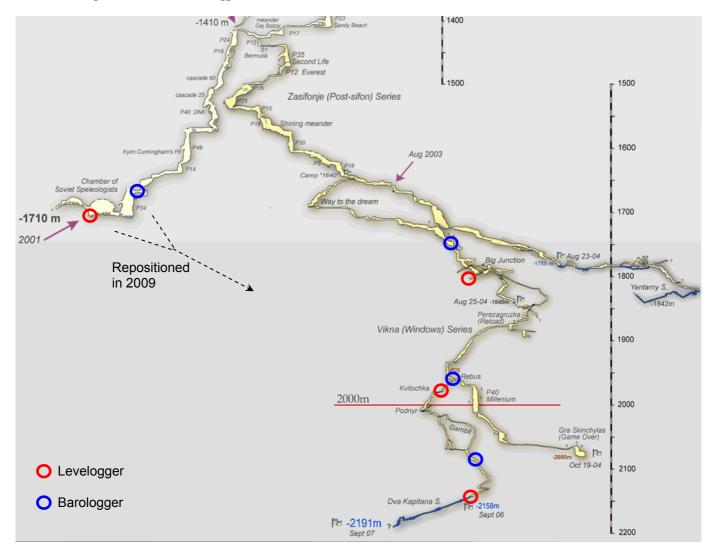


Figure 14.1: Water Level Logger Placement

During the 2008 expedition, 2 sets of loggers were placed as follows.

Location	Instrument	Depth, metres
Chamber of Soviet Spelanderists	Levelogger	-1,710
Chamber of Soviet Spelaeologists	Barologger	-1,676
Dia Junation	Levelogger	-1,806
Big Junction	Barologger	-1,760

At the Big Junction, the Levelogger was placed just above the normal water level of a sump off the main passageway. In the Chamber of Soviet Spelaeologists, the Levelogger was positioned at the lowest part of the chamber, which is the first place to become flooded during wet conditions. In each case, the corresponding Barologger was placed in a dry area above the Levelogger where there was no risk of flooding.

On the 2009 expedition, SUI sponsorship allowed purchase of a further Levelogger and Barologger, a downloading portable device (the Solinst "Leveloader"), and cables and connections for linking to instruments and to a PC. The instruments from the Chamber of Soviet Spelaeologists were

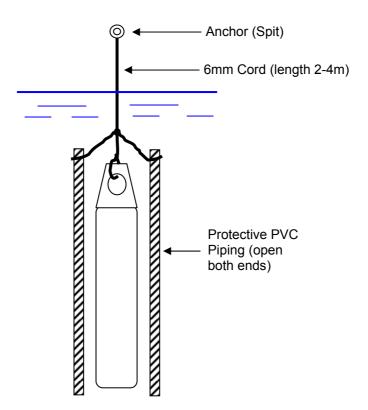
transferred deeper into the cave, and the new instruments were installed at the terminal sump, as follows.

Location	Instrument	Depth, metres
Dia Jupation	Levelogger	-1,806
Big Junction	Barologger	-1,760
Kvitochka Sump	Levelogger	-1,980
KVItociika Suirip	Barologger	-1,950
Dya Kanitana (Tarminal) Sumn	Levelogger	-2,145
Dva Kapitana (Terminal) Sump	Barologger	-2,080

The frequency of readings was increased from 30-minute intervals to 15-minute intervals. The Leveloggers were rearranged from their postions just above the normal water level to a submerged position at all times. This meant that they could give continuous useful data throughout the year, rather than only during flood conditions when water rose enough to submerge them.

The data downloaded to the Leveloader was subsequently uploaded to PC on the surface.

Figure 14.2: Levelogger Anchorage



Results and Discussion

This section reports the results downloaded from loggers placed in 2008. The quality of the data was good, with no gaps or obvious irregularities. Readings began on 05 September 2008 and continued until the download date of 22 August 2009. Approximately 16,800 readings were taken by each instrument. Results are depicted in Figures 14.3 and 14.4.

Figure 14.3: Water Level, Big Junction (-1,806 metres), Sep 08-Aug 09

Big Junction Water Levels, m

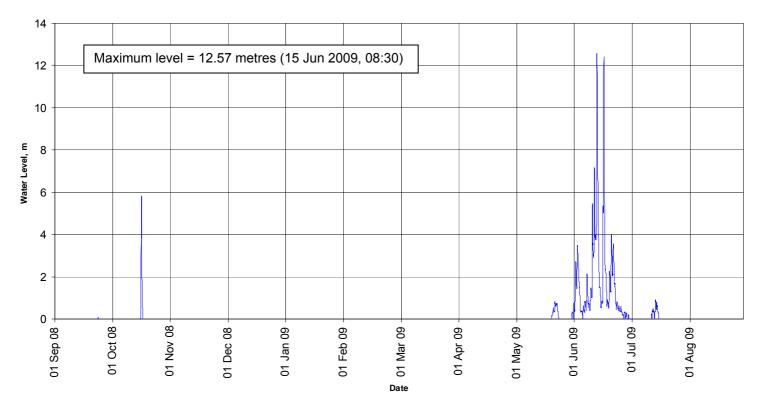
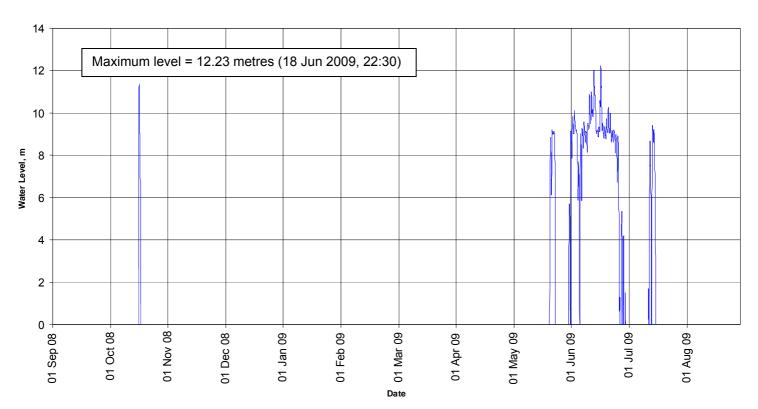


Figure 14.4: Water Level, Chamber of Soviet Spelaeologists (-1,710 metres), Sep 08-Aug 09

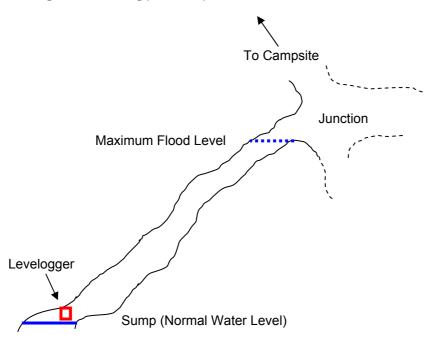
Soviet Spelaeologist Water Levels, m



The main flooding period during 2008-2009 was mid-May to mid-July, corresponding with summer thaws on the surface. There was also a flood peak in October, presumably corresponding to heavy surface rainfall.

The maximum level reached at the Big Junction was 12.57 metres (on 15 June 2009). This height is thought to be the top of the descending tube to the sump where the logger is located, and therefore the campsite at ca. 1,800 metres would appear to be safe from flooding. The maximum speed of flooding during this peak is 2 metres/hour.

Figure 14.5: Big Junction Flooding (Postulated)



In the Chamber of Soviet Spelaeologists, the maximum flood level was 12.23 metres (on 18 June 2009). The flood rate (rate of increase in water level) fluctuates according to the contours of the walls as the chamber fills, but settles at a constant rate of 1 metre/hour for most of the filling stage. With an estimated chamber diameter of 15 metres, this would imply an estimated fill rate of 177 cubic metres/hour (approximately 50 litres/second).

Figures 14.6 and 14.7 are "zoomed" graphs of the May-July flooding period. In these, daily fluctuations in water level are clearly visible, corresponding to daily fluctuations in temperature, and hence snowmelt, on the surface.

The flood responses in each location are closely linked. For example, both locations have their maximum flood spikes of the year on the same dates (15 and 18 June 2009), the Big Junction maximum peak lagging behind the Chamber of Soviet Spelaeologists by only 1 hour.

Figure 14.6: Water Level, Big Junction (-1,806 metres), May-Jul 09

Big Junction Water Levels, m

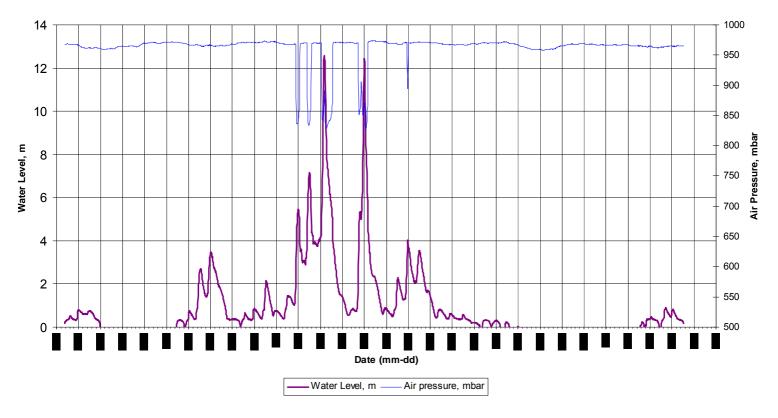
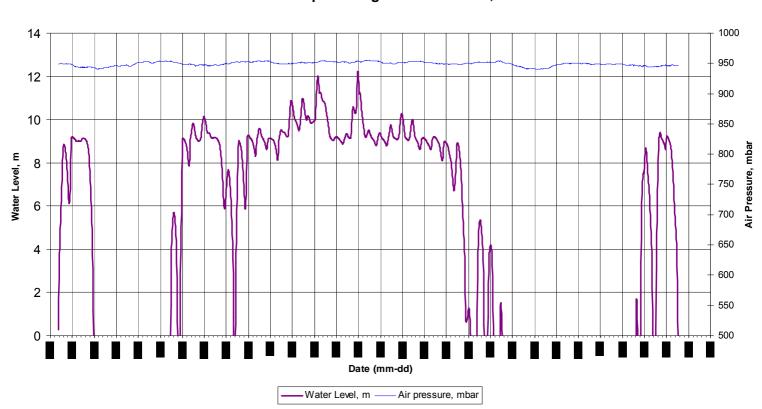


Figure 14.7: Water Level, Chamber of Soviet Spelaeologists (-1,710 metres), May-Jul 09

Soviet Spelaeologist Water Levels, m



Figures 14.6 and 14.7 also show the corresponding Barologger data for each location in millibars. There is an interesting drop in ambient air pressure, which is peculiar to the Big Junction. It only occurs at precisely the same time as water level peaks, but only when the water level reaches 4 metres or more.

The magnitude of the pressure drop is typically 130-140 mbar, which occurs over a period of 1.5 hours. For comparison, 140 mbar is the pressure drop experienced during an ascent of 1,240 metres from sea level.

Such a pressure decrease could theoretically cause decompression sickness in a diver after a long, deep dive.

One hypothesis to explain this phenomenon is shown in Figure 14.8, where the "Way To The Dream" passage has been sumped off, and the flow rate in the lower part of the passage is greater than in the upper part. More investigation will need to be done to determine the cause.

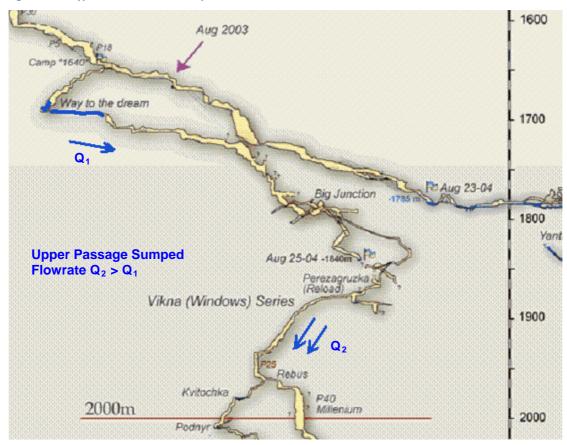


Figure 14.8: Hypothesis for Pressure Dips

Temperatures in the cave were very constant, with slight fluctuations in line with the flooding events. Minimum and maximum temperatures are summarised below.

Location	Water Temperature, °C (min/ max)	Air Temperature, °C (min/max)
Big Junction	5.82 / 6.29	6.05 / 6.94
Ch. of Soviet Spelaeologists	5.59 / 5.87	5.59 / 5.86

Further Work

In 2010, it is intended to place a further Barologger at the surface to obtain a baseline atmospheric pressure as well as surface air temperatures.

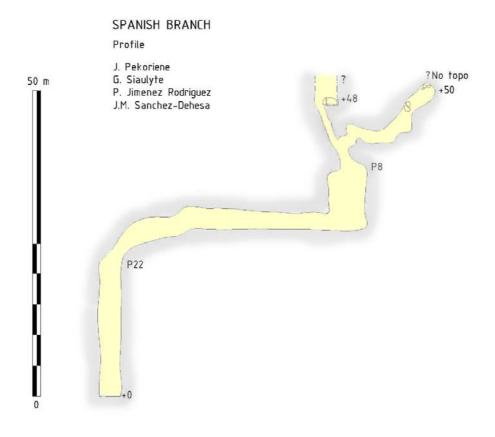
A correlation between surface temperature, snowmelt rate and underground flooding will hopefully be possible.

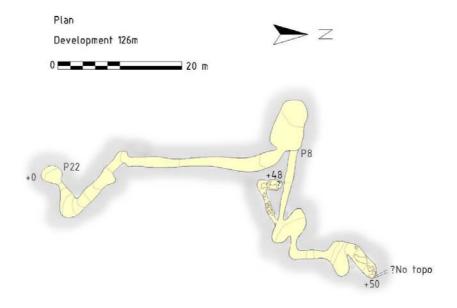
Investigating the pressure differential between the surface and an underground instrument will allow an estimate of the depth of that instrument. The accuracy of this estimate will only be known when the data become available, but it may prove useful in confirming the true depth of the world's deepest cave.

15. Exploration at -1,340m, Spanish Branch

In 2009, we continued exploring the Spanish Branch. In 2008 we finished bolting the first, 22m pitch but were stopped by a subsequent short pitch. This pitch was bolted to a split in the passage and a further two avens, both ongoing leads.

Figure 15.1: Spanish Branch Survey





For bolting, we used electric drills and Russian-made "knee-hooks". These are very lightweight and comfortable, and allow a 1-metre height gain per bolt (which could be stretched to 1.5 metres at a push). They consist of strapping worn on both lower legs, with a metal hook situated at each knee. A metre-long tape is hooked onto the uppermost anchor, and the knee hooks can be used to walk up a series of metal rings sewn into the tape.

Time shortage and water damage of some batteries curtailed further exploration in 2009.

16. Animal Life

During the 2008 Call of the Abyss expedition, we found a large number of flying insects at a depth of 1,700 to 1,800 metres. Most were dead, although we managed to collect some living specimens. These were damaged during our return to the surface and identification was not possible.

In the 2009 expedition, we equipped ourselves with proper specimen bottles and Spanish zoologist-caver Jesús, with a view to identifying these creatures. We believe that they were carried into the cave by cavers and survive on the human waste at the campsites. They could play an important part in decomposing this and keeping the cave clean.

Unfortunately, there were no suitable specimens to be found during the expedition – all were dead and too damaged by the water to be of any use. However, our sample bottles did come in handy to collect another guest found at Camp -1,400: a small scorpion.



This was transported back to Spain, where it was identified as a troglobitic pseudoscorpion – see paper attached.

A less welcome discovery was that of parasitic worms in the water supply at the surface. These were only just visible, being very thin and about half a centimetre long. After finding them, we made sure that all snowmelt water was boiled for several minutes before use!

New record of the troglobitic pseudoscorpion Neobisium (Blothrus) birsteini Lapschoff, 1940 from Krubera-Voronja cave, Western Caucasus (Arachnida: Pseudoscorpiones: Neobisiidae)

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Abstract

The pseudoscorpion *Neobisium (Blothrus) birsteini* Lapschoff is recorded for the first time from the famous Krubera-Voronja cave, Abkhazia. Short description of the unique specimen found is provided and morphological variability discussed.

Key words: Pseudoscorpiones, new record, cave, Krubera-Voronja, Abkhazia

Introduction

During summer 2009, since August 9 to September 4, an international expedition explored the deepest cave in the world: Krubera-Voronja, the team of 19 cave explorers from England, Hungary, Ireland, Lithuania and Spain was integrated within the project "Towards the centre of the Earth", coordinated by the Lithuanian caving club "Aenigma" and under the organization of the Ukranian Speleogical Association (UkrSA). Krubera-Voronja cave is located in the Arabika Massif, Western Caucasus, in the Gagra District of Abkhazia, Georgia; the cave itself and the karstic circulation system in the limestone massif of Arabika has been studied for a long time (p.e. Martel, 1909; Klimchouk, 2004; Klimchouk et al., 2008).

The expedition objectives were to reach the deepest zone of the cave (-2.150 metres), replacement of damaged or too old ropes, installation of digital stream level gauges, exploring and surveying unknown zones of the cave for the preparation of detailed maps and documenting discoveries through photography and video.

An additional objective was to collect cave insects (mosquitoes) for taxonomical study. Discovery of a large troglobitic pseudoscorpion at 1.420 metres depth was a nice surprise for the collectors. The specimen has been assigned to the species *Neobisium (Blothrus) birsteini* Lapschoff, 1940 and Krubera-Voronja cave represents a new record for the species.

Taxonomy

Superfamily Neobisioidea Chamberlin, 1930 Family Neobisiidae Chamberlin, 1930 Subfamily Neobisiinae Chamberlin, 1930 Genus *Neobisium* Chamberlin, 1930 Subgenus *Blothrus* Schiödte, 1847

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Neobisium (Blothrus) birsteini Lapschoff, 1940 *Blothrus birsteini* Lapschoff, 1940: 62-63, 73, figs 1-2

Material. Krubera-Voronja cave, Gagra District, Abkhazia, Georgia; coordinates: WGS84 43° 24′ 35″ N, 40° 21′ 44″ E, 43.409722, 40.362222; 23-VIII.2009, collected by Jesús Martínez Sánchez-Dehesa, 1.420 metres depth, on clay soil close to watercourse: one female, deposited in Departamento de Ecología, Facultad de Ciencias, Universidad de Alicante, Alicante, Spain.

Short description. Large size. Troglobitic shape, pedipalps and legs slender, declerotized. Opisthosoma and legs pale brown, carapace, chelicerae and pedipalps reddish. Carapace elongate; epistome triangular, long and acute; chaetotaxy: 33 setae, formula: 4:11:6:5:7. Without eyes or eye-spots. Chaetotaxy tergites I-XI: 6: 6: 6: 6: 8: 9: 7: 9: 8: 4. Chelicera: palm with 6 setae, subgaleal seta on movable finger 0.69 from base; spinneret uniformly rounded, not prominent; fixed finger with 14 small and medium size teeth; movable finger with 11 teeth, medial with a large tooth. Apex

of pedipalpal coxa long, with 5 setae on each side: anterolateral process of coxa I with small simple tooth shape, apically blunt; medial process slightly prominent. **Pedipalps** trochanter smooth. with a weak distal tubercle; femur 1.48× longer than the finger and $1.21 \times$ longer than the patella; finger 1.24× longer than the hand with pedicel. Leg IV claws with a tiny tooth basal of dorsal side, subterminal setae distally feathery. Ratios (length/width) and measurements (in mm): Body length: 6.548; carapace $1.39 \times (2.12/1.52)$; chelicera: palm $2.09 \times (1.34/0.64)$ movable finger length: 0.84; pedipalp: trochanter $2.89 \times (1.62/0.56)$, femur



1. Habitus of Neobisium (Blothrus) birsteini Lapschoff, female specimen from Krubera-Voronja cave (photo: Juan A. Zaragoza)

 $7.72 \times (4.48/0.58)$, patella $5.97 \times (3.70/0.62)$, chela with pedicel $5.40 \times (2.70/0.50)$, hand with pedicel $2.44 \times (2.44/1.00)$, finger length: 3.02.

Discussion

Three cave-dwelling species of the family Neobisiidae are recorded from the Caucasus: *Neobisium (Heoblothrus) sakadzhianum* Krumpal, 1984, from Sakadjia cave, Tskhaltubo, Georgia; *Neobisium (Blothrus) verae* (Lapschoff, 1940), from Georgia: Gogoleti cave and Nikorstminda cave, both in Ambrolauri District, and Sataplia-1 cave near Kutaissi; *Neobisium (Blothrus) birsteini* (Lapschoff, 1940), type locality: Tarkiladze cave, Gudauten, Abkhazia, Georgia, also from different caves of Abkhazia and various caves of Krasnodar province, Russia, and Kabardino-Balkaria (Dashdamirov & Schawaller, 1992). No additions to these records from caves of the Caucasian region have been done up to date (Harvey, 2009).

After Mahnert (1979) redescription of the types of N. (B.) birsteini and N.(B.) verae, description and records of new samples of both species from different localities were made by Schawaller (1983), Schawaller & Dashdamirov (1988) and Dashdamirov & Schawaller (1992). By morphological and morphometric data, the specimen from Krubera-Voronja cave is tentatively assigned to the species N. (B.) birsteini. A key to the Caucasian pseudoscorpions was provided by Dashdamirov & Schawaller (1992), following it, the diagnostic of the examined specimen shares with N. (B.) birsteini a well developed carapacal epistome and palpal chela about 5.50×10^{-9} longer than wide versus a short epistome and chela $7.50-9.50 \times 10^{-9}$ in N. (B.) verae.

Dashdamirov & Schawaller (1992) pointed out the high variability that show specimens from different zones assigned or close to *N. (B.) birsteini*, particularly in morphology. The studied female from Krubera Voronja cave also differs with the holotype of *N. (B.) birsteini* bearing 7 setae on the posterior margin of the carapace versus 4, but although this character is not mentioned in Dashdamirov & Schawaller (1992) Dr. Selvin Dashdamirov (in litt.) has confirmed that some variation in chaetotaxy also occurs. Both mentioned authors conclude that, for a definitive specific assignation of those specimens, new abundant material ought to be collected from caves.

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17. Sponsors

We would like to thank our main sponsor, the Spelaeological Union of Ireland, whose funding helped to buy long-term monitoring equipment that will enhance the safety and planning of future expeditions and further the understanding of Krubera-Voronja's hydrology.



Speleological Union of Ireland & IRISH CAVE RESCUE ORGANISATION



Our sincere thanks also go to the many other generous sponsors, listed below alphabetically.

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18. References & Links

Information on Krubera-Voronja Cave and the Arabika Karst		
History of recent exploration (2004	www.speleogenesis.info/spotlights/sp	
onwards)	otlight areas.php?expl area id=4	
Hydrolevelling method of determining	www.rgo-	
cave depth	speleo.ru/eng/biblio/hydroniv-e.htm	
General article on location, geology &	en.wikipedia.org/wiki/Krubera Cave	
hydrology, history	CH:WINDCald.Org/WINI/TYTODCTO_OUVC	
Detailed exploration history, up to the		
discovery of world depth record	www.cavediggers.com/Voronja.pdf	
-1,710m		
Publicity		
BBC coverage of 2004 discovery of	news.bbc.co.uk/1/hi/sci/tech/4472585	
"Game Over"	<u>.stm</u>	
National Geographic Article on 2004	ngm.nationalgeographic.com/ngm/05	
discovery	05/feature4/multimedia.html	
2009 "Towards the Centre of the	speleo.lt/speleo/aidas/portfolio/gilyn2	
Earth" Expedition Brochure	009en small.pdf	
Various presentations, photos, etc.	ftp.speleo.lt/speleo/aidas/presentation	
from 2009 expedition	itp.speieo.it/speieo/aiuas/presentation	

Appendix 1: Travel and Visa Arrangements

The most cumbersome part of the expedition was the arrangement of visas. Below are pointers which are accurate at the time of writing for Irish citizens.

Travel

The most convenient route we found is as follows, and takes a whole day.

Flight	Ireland to Moscow	From Dublin or Belfast, usually via London or mainland Europe	
Flight	Moscow to Sochi (Adler airport, near Black Sea)	2½ hours	
Public	Sochi to Russian/Abkhazi	30 minutes – buses in airport carpark,	
Minibus	border	look for "Psou" (Псоу)	
Walk	Across border	30-60 minutes – Footbridge crossing with Russian and then Abkhazian border control	
Public Minibus	Border to Tsandripsh	30 minutes – buses at border, look for "Gagra" direction (Γαгρα)	

There are plenty of airlines to choose from. Minibuses were very cheap (€1-2).

Note – Sochi will be the site of the 2014 Winter Olympics, so this will probably impact positively on the travel infrastructure but negatively on the cost of travel!

Russian rubles are required in both Russia and Abkhazia.

Visa – Abkhazia

A tourist, single-entry visa is required from the Abkhazian Ministry of Foreign Affairs.

- Visit www.mfaabkhazia.org/en/ and download the visa application form.
- Email the completed form and a scan of your passport photo page back.
- You will be emailed a pdf clearance letter within a couple of weeks (follow up if not).
- Print this letter for use at the Abkhazian border with your passport.
- Once in Abkhazia, travel to the capital Sukhumi to buy your visa (\$20) otherwise you will have difficulty leaving the country on your way home!

Visa – Russia

For Irish citizens, visas must be purchased in the Russian Consulate in Dublin.

- Visit http://www.ireland.mid.ru/ and follow the online visa application form instructions. The online form can be started and finished at a later date.
- The visa type should be TOURIST, DOUBLE-ENTRY (1st entry to fly to Moscow, 2nd entry to return from Abkazia).
- The points of destination on your journey are "Moscow" and "Sochi".
- The reason for travel should be stated as simply "Tourism" not recommended to mention either "caving" or "Abkhazia".
- You need a Tourist Acceptance Confimation and Tourist Voucher (a.k.a. Tourist Invitation, Visa Support Documents). These can be purchased online for about €25 see for example www.destinationrussia.com/russian_visa_tourist_order.aspx. On completion of the payment you will be emailed back a pdf of your documents within a day. This must be printed and submitted with your visa application to the consulate.
- For your application you need to submit
 - Application form, signed
 - Passport photo
 - Your passport (original passport, valid for at least 6 months beyond your stay)
 - Tourist Confirmation & Voucher
 - o Postal order for €100
- Processing time takes usually 2 weeks but highly recommended to apply at the very least a month in advance.

Appendix 2: Expedition Finances

EXPENDITURE				
Item	Cost fo	_	Actual Cost	
	Budget	Actual	p.p.	
Travel & insurance				
Return flight Dubin-Moscow	700	873	437	
Return flight Moscow-Sochi	500	557	279	
Transit visa Russia (tourist double-entry)	200	280	140	
Tourist invitation (for Russian visa)	60	50	25	
Postage/travel costs for visa	-	15	8	
Insurance	200	151	76	
Other (overnight stay in Adler, food, etc.)	-	80	40	
Shared Expedition Costs				
Abkhazian visa Transport from Sochi to mountain Ropes & rigging equipment Communal equipment, fuel, food, medicine, etc.	800	400 ¹	200	
Personal Equipment				
Drysuit	240	246	123	
General caving kit replacement (new & spare kit needed for week's stay underground)	400	400	200	
Water Logging Equipment – Irish team				
Gold LT M100 Temperature and Levelogger Gold Barologger M1.5 Leveloader Gold PDA Standard Communications Package (USB) P&P	1,500	1,801	901	
TOTAL	4,600	4,853	2,427	
INCOME ²				
Manage 1			Amount	
Item		Team	p.p.	
SUI Expedition Grant			1,200	
Waterra Sponsorship			250	
Contributions from team members			977	
TOTAL			2,427	

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¹ Irish Team fees reduced from €400 to €200 per person as return gesture for SUI funding of expedition.

expedition.

² The expedition was also funded by the European Speleological Federation (FSE) and local Lithuanian sponsors. This funding was taken into account in setting the expedition fees at €400 per person.