# IMPERIAL COLLEGE
# BOGDA SHAN 2000
# EXPEDITION

PRELIMINARY REPORT
20TH NOVEMBER 2000

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## Bogda Shan 2000 Expedition Overview

During the month of September, six postgraduate geologists from Imperial College worked in and around the Bogda Shan mountain range, in the Autonomous Province of Xinjiang, Northwest China.

The aim of the Expedition was two-fold. Firstly to attempt to construct an annotated topographic profile across the Mountain range from the Tarim Basin in the south to the Jungar Basin to the north. Secondly, we also intended to examine the geological structures and rock types found in the region. With both a topographical cross-section and a regional understanding of the geological structures we hope to be able to elucidate the main process that are responsible for the formation of the Eastern Extent of the Bogda Shan range – and perhaps the Tien Shan as a whole.

The Expedition was undertaken in collaboration with the Seismological Bureau of Xinjiang, Uygur Autonomous Region. The Bureau, part of the Department of Seismology of China, is an important government department. The province of Xinjiang has a high level of earthquake activity, some of which is highly destructive with several magnitude 8+ earthquakes occurring during the last century. With the capital, Urumqi, being such a populous city they are clearly interested in prediction and developing an understanding of the region – in particular around Urumqi. They were therefore particularly interested in our work and imagery. Kindly, they helped organise the fieldwork, providing two excellent field geologists for the Expedition for the majority of our time in Xinjiang.

The main data source for planning our field locations was Landsat 7 ETM imagery. From the imagery we defined rock types and structures that we believed to be important to investigate whilst in the field. Once we arrived in China a series of detailed meetings with the Seismological Bureau allowed us to revise our fieldwork.

We also hope to show how remotely sensed imagery can be used for the planning of fieldwork in remote areas where access to topographical maps is difficult.

Additionally, we also undertook to survey the front of the two main glaciers on the northern and southern sides of the range using GPS. We then intend to compare the data to US spy satellite photography (recently declassified) to ascertain if this is a viable technique for tracking possible glacier retreat.

## Expedition Planning

### GIS and Data Used

The Expedition was able to procure several sources of data that became useful in the pre-expedition planning and fieldwork. As well as an exhaustive literature search we were also able to obtain several sets of data that could be combined in a GIS. The database included the following items:

Landsat ETM 7 Satellite imagery
Corona US Satellite photography
1:1,000,000 Topographic maps
1:500,000 Tactical Pilot Charts
1:250,000 Topographic Maps – (Ex-Russian military)
1:500,000 Regional Geological Map
1:250,000 Geological Map Subsections

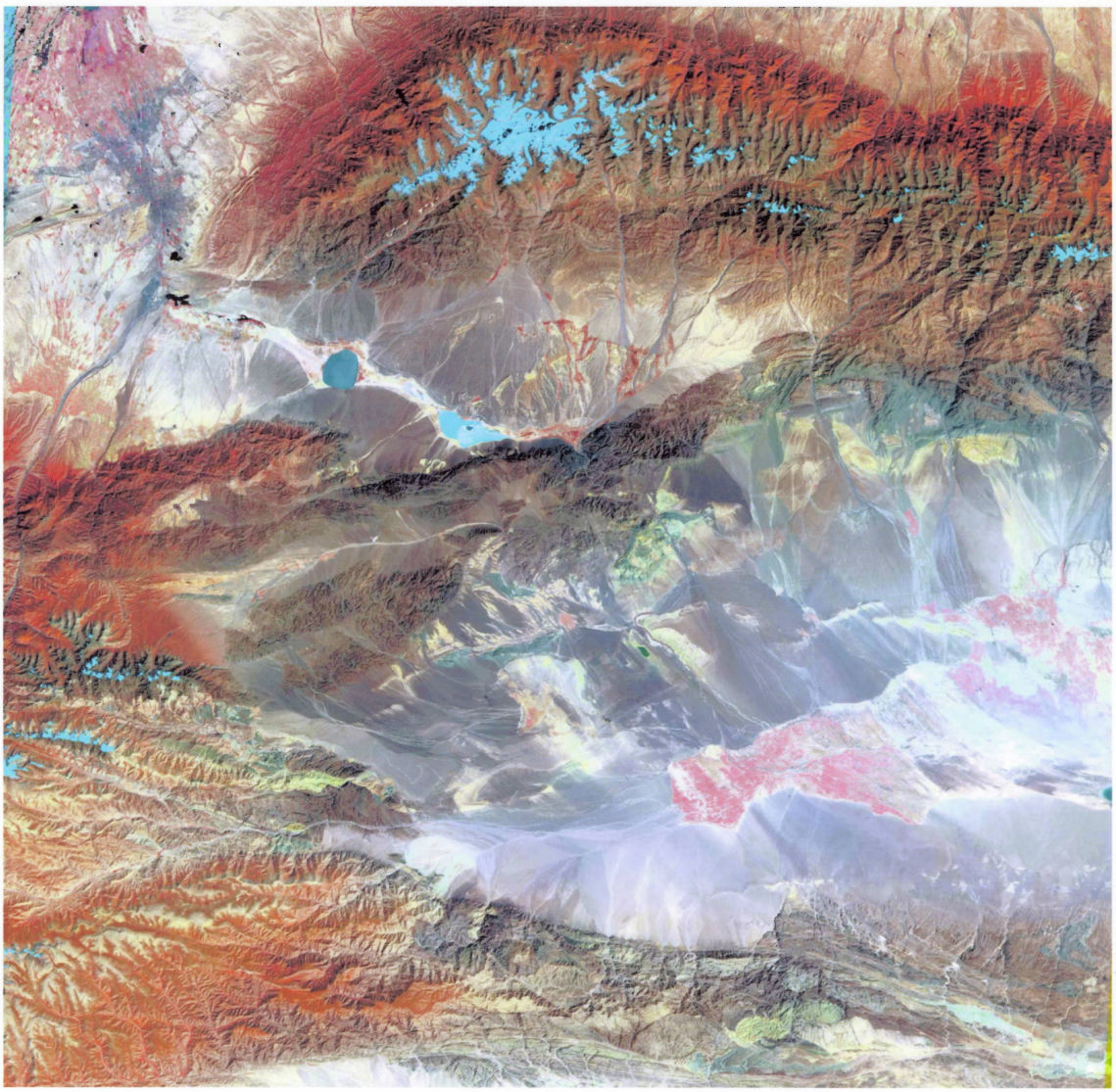
### Logistics

Our time in the field was divided according to where in the region we were working. Whilst working in the Turfan area, 4x4 vehicles were used as important localities identified were often some distance from roads. Fortunately, the terrain was well suited to this type of transport.

Whilst in the mountains all movement was undertaken by foot. All our equipment was moved to and from base camps by camels on the southern side of the mountains and mules on the north.

**Group photograph outside seismological Bureau Xinjiang**
Top Row Left to Right: Alex Davis, Daniel Hourigan, Philippa Mason, Joerg Herwanger
Bottom Row Left to Right: Martin Whiteside and Alex Atkinson

**Figure 1 Landsat Scene of Bogda Shan Area Displayed in 531**



**Bogda Shan and Turpan Depression.** 531 Landsat Subscene.
Turpan Depression shown as the pink/grey area to South.
Nan Shan shown as dark, ENE-SSW trending dark band South of lakes.

**Overview of locations visited:**

There were essentially three areas within the Tarim Basin / Bogda Shan Mountain Range visited by the expedition.

1. The Turfan Depression / Flaming mountains
2. Southern side of the Bogda Shan
3. Northern Extent of Bogda Shan
    a. Northern side of the Bogda Shan
    b. Northern flank / Jungar Basin

**The Turfan Depression and Flaming mountains**

This was the first of our field visits. Based out of the famous Silk Road oasis of Turfan we spent five days investigating the geological structures in the region. The Turfan Depression itself was important to visit as it represents a major area of low elevation – which directly contrasts with the Bogda Mountains to the north. The locations were chosen through the combination of our Chinese guide's experience and Landsat imagery. As accurately as possible the locations were selected to be on the line of section from which the profile will be constructed.

Immediately to the north of the Depression are the Flaming Mountains. These were important to investigate as they displayed active faulting. On leaving the Turfan depression we had gained an excellent overview of the structure and neotectonics of this important region.

**The South side of the Bogda Range**

On September 8th the Expedition drove from Urumqi to the head of the valley seen on the image. Having reconnoitred the valley the previous week, we were meet at the head of the valley by two Kazak herdsmen.

This valley was chosen for a number of reasons:

As can be seen from the imagery, there appeared to be direct access to the core of the mountain range. This was vital if our objective of obtaining a complete topographic profile was to be achieved. Both this and the presence of good campgrounds were confirmed by our Kazak porter. This valley also enabled us good access to other major valleys. This was important if we wished to visit as many rock exposures as possible.

**Northern Side of the Range**

The northern side of the range was far more accessible; the lake seen on image 3 is popular with Chinese tourists. Access to the lake itself was therefore straightforward.

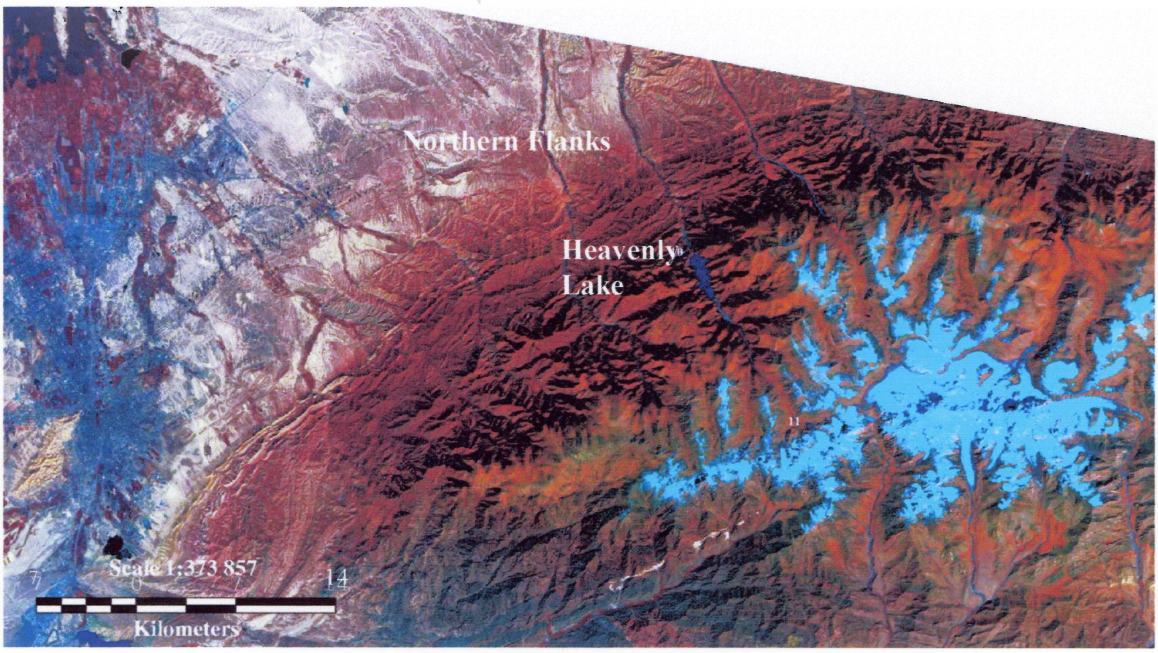
Base camp on the northern side was chosen within the tree line. From here we would be able survey the main valley running from the glacier down to the lake. A team was dispatched to establish a high camp where the topographic profile could then be linked together. Another team was given the task of surveying river profiles in the area in an attempt to ascertain the level of neotectonic change. This is discussed

below in the following section. Again – the Landsat and our Chinese friends were our main source of information when planning where to go.

**Northern Flank – Jungar Basin**

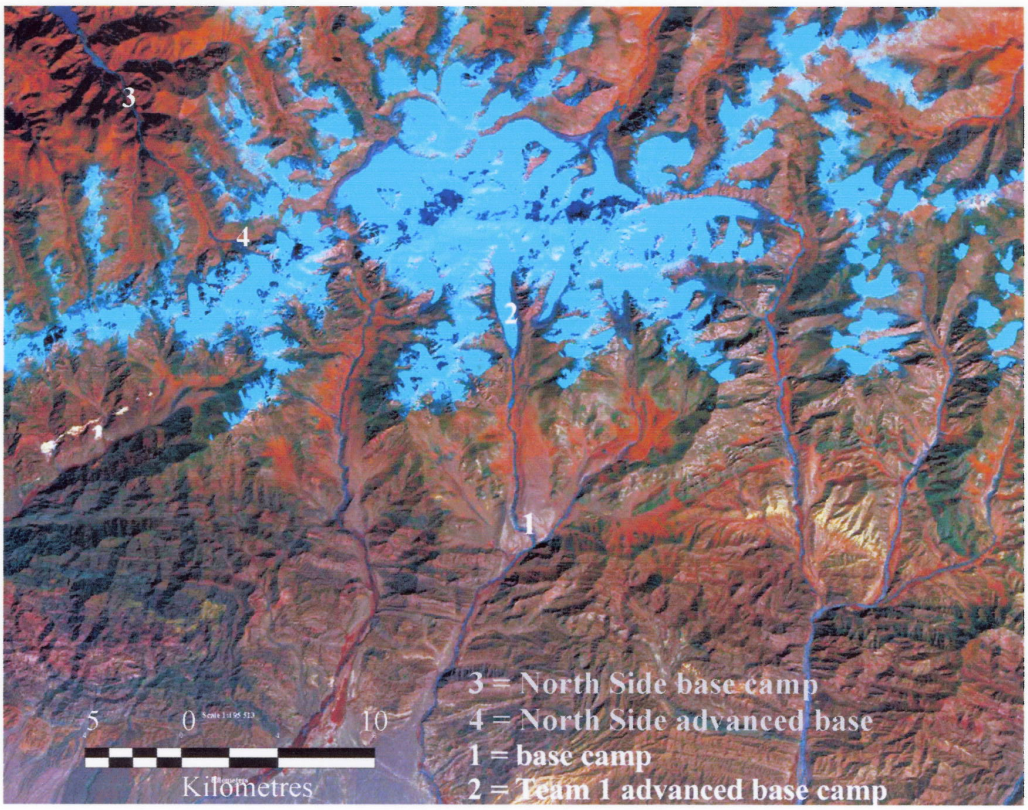
After the fieldwork within the mountains had been completed the team spent a day investigating the geological features found on the northern flank of the mountain range. This allowed the investigation of the major fault bounding the basin with the mountain range. Again this would prove vital in understanding the neotectonics of the region.

**Figure 2 LandSat Image Showing Northern Areas Visited By Expedition**




**Area to North of glacier.** 531 Landsat Subscene.
Urumqi city can be seen as the North- South sprawling blue-grey area to the west. The South side glacier is displayed in the East Centre of the Image, in light blue.
Image Approx 75 kilometres across

**Figure 3 Showing Central Region Visited By Expedition**




**Glacial Area.** 531 Landsat Subscene.
Both North and South base camps can be identified on Subscene.
Image approx. 40 Km. Across
North to Top

## Overview of Information Gathered at Locations

As mentioned in the Overview of Visited Locations, the expedition was divided broadly into two distinct methods over four sections. The two methods were the use of landcrusiers for mobile investigations and fieldwork centred around a base camp, or advanced base camp within the mountains.

*Mobile Investigation 1: (4 days) Monday 4th – 7th September. (Turfan and Nan Shan)*

The team found several examples of active or recently active fault traces. Under the guidance of our Chinese colleagues we managed to see faults believed to have been active within the last few hundred years. The team also managed to drive through the Nan Shan constructing a GPS profile through the area as well as conduct broad scale basic lithological mapping.

*Field Work 1: (10 days) Friday 8th – 17th September (Southside Bogda Shan)*

The party split into two teams, one camped in the lower valley, and an advanced base camp at the terminus of the glacier. The lower team explored the relationship between faults and glaciation, as well as the broad-scale geology and geomorphology. The advanced base camp party mapped the extent of the glacier with a view to monitoring glacial retreat. The lower team identified the lithologies and the tectonic regime of the mountain forming processes. The GPS sets were used to construct an X-Y-Z profile that will be annotated with collected geological and geomorrphological information.

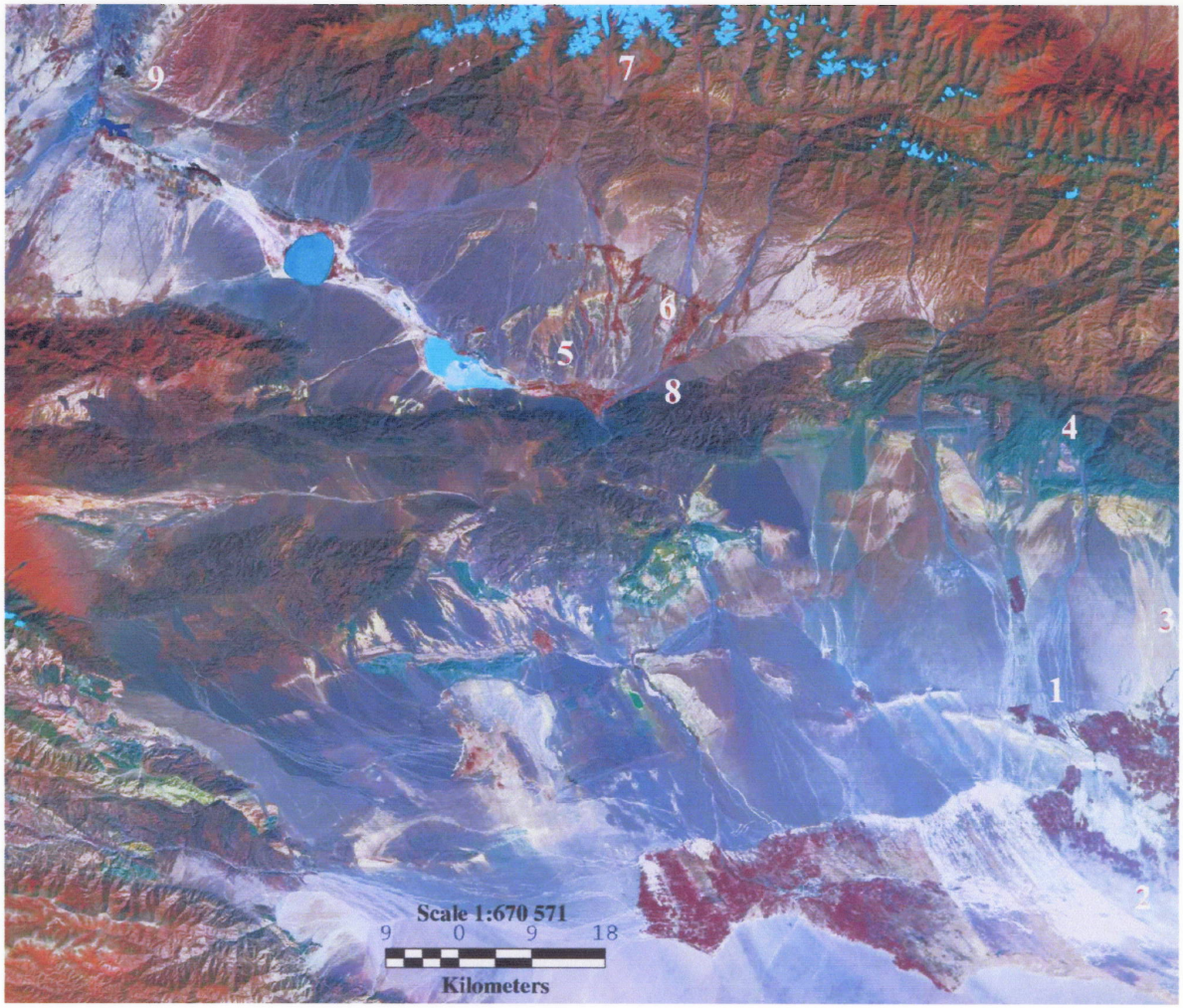
*Field Work 2: (8 days) Tuesday 19th-26th September (North Side Bogda Shan)*

The team moved across the Tian Chi(Heavenly Lake) with an aim to connecting the profile across the mountains. The expedition mapped the northward verging thrusts that move out over the Junggar Basin. The northside geology was far more inaccessible due to the steeper valley slopes. As such more attention was placed on the collection of geomorphological data. This included collecting profile data to map the development of the down-cutting within two sub-parallel streams.

*Mobile Investigation 2: (2 days) Friday 29th – Saturday 30th (Bogda Shan flanks)*

The fourth stage of the project was a two-day mobile reconnaissance of the flanks of the Mountains. This involved the study of fault-controlled drainage near the margins of the southerly vergence. The team also observed local mining techniques and deposits, by visiting coalmines and open cast limestone/marble extraction. The final day examined the northern flank of the Bogda Shan as it encroaches, by thrusting onto the Jungar Basin.

**Figure 4 Landsat ETM 7 Subscene of Areas Visited in the South.**




**SouthSide** 531 Landsat Subscene.
Area Investigated during Mobile Investigations
(*Monday 4th – 7th September) & (Friday 29th)*
and Field Work *(Friday 8th – 17th September)*
North to Top

**Key to Locations. See Itinerary For Further Details**

**1** Area around Turpan
**2** Salt Lakes
**3** Areas near Flaming Mountains, showing recent tectonic activity.
**4** Southern Flanks showing Southerly vergence into basin.
**5** Dabachang (Town near Mines investigated on 29th September)
**6** Fault controlled drainage investigated on 29th September
**7** Southside base camp
**8** Drive through Nan Shan 7th September
**9** Folds close to Urumqi

## Financial Statement

The Imperial College Bogda Shan 2000 Expedition was fortunate to be funded and supported by many organisations. The main funds came from the people and organisations listed in table 1. The expedition expresses a deep gratitude to those persons who made it possible to fund fieldwork in a remote and until recently inaccessible part of the world.

**Table 1**

| Money Raised | |
|---|---|
| Imperial College Exploration Board | £3,000 |
| Royal Geographical Society | £2,500 |
| Convocation Fund | £600 |
| Silva Award | £100 |
| Student Contributions | £3,000 |
| Total | £9,200 |

Careful pre-expedition budgeting and close monitoring in the field allowed the expedition to be completed within its designed financial plan. However, lack of detailed information from the part of the world visited made exact figures difficult to obtain before we left. When compared to our pre-expedition financial tables, the actual totals balanced closely. The services obtained in the field, such as vehicle and animal hire, and translator/scientist fees came in higher than expected, but living expenses came in substantially lower.

The expedition was also hindered by unfavourable pound sterling fluctuations during the July through October months, with the pound starting strongly against the Yuan, in August and falling sharply. This meant the purchasing of currency fell well below the budgeted 13-14 Yuan/Pound exchange rate we had included in our calculations even dropping below the 10.5 Yuan exchange rate. Fortunately, this was slightly offset by a strong dollar, which we had purchased in travellers cheques before leaving.

**Table 2**

| Approx. Expedition Expenses | Yuan | Approx. Conversions Pound |
|---|---|---|
| Flights (International) | - | £2180.4 |
| Flights (Internal) | 12000 | £1150 |
| Train | 4132 | £400 |
| Pre Expedition | - | £1675 |
| Chinese Administration Charges | 1045 | £100 |
| Translators | 7127 | £680 |
| Vehicles | 11481 | £1050 |
| Communications | 2250 | £200 |
| Accommodation | 7689 | £750 |
| Mountains Supplies | 2120 | £210 |
| Mountain Provisions | 2040 | £200 |
| Food Within Towns | 1000 | £100 |
| Misc. | 3125 | £275 |
| Approx. Total Cost | | £8970.4 |

## Further Work

### Potential Outputs

#### Electronic Data

The Bogda Shan 2000 Expedition collected a very large quantity of data, including over 5000 individual GPS locations over a stretch of mountains 200 kilometres across. This data is still being collated and analysed and will be combined with geological readings and observations in the construction of the final report. The data is calibrated from a detailed study on the handsets used in the field. This control consists of nearly 500 GPS control points from a location of known co-ordinates over three separate periods of time to act as a control.

Given the nature of the project, the use of digital imagery and computer recorded data points, the most logical method for data presentation is not in hardcopy reports but in electronic format. Though the expedition will be releasing reports and possibly papers on the area, one of the main focuses of the work will be to create a queryable online graphical database for the data. This will take the form of a geo-rectified image overlain with GPS co-ordinates linked to a database of geological data. The website will then allow certain criterion to be selected and thus displayed on the accompanying image.

The database is built in Visual Basic 6, above a series of Excel 2000 Spreadsheets where the data is stored. The choice for Excel above Access was taken to maximise the ability for the product to be reused by persons with little computer knowledge. The Application will be imbedded into a HTML website with no requirement for Excel to be run for the queries or data to be display. It will function as a standalone product on the web.

#### Hardcopy Data

A report summarising all the work, including the geological and geomorphological fieldwork as well as information on the land and people will be presented to the relevant organisations. A brief outline for this is included in Appendix 1. Hardcopy images both, Landsat TM and Corona as well as plotted GPS locations for reference to field days will be included in this report. A brief breakdown of the itinerary can be seen in Appendix 2 and an example of an annotated Landsat scene is included as figure 2. The data will be plotted onto the hardcopy of the transect, which was the focus of the expedition.

It is the hope that some of the work carried out will be of high enough quality to see publication in one or more journals. At present, our main aims are the use of GPS data in conjunction with satellite data to measure glacial retreat. The expedition is fortunate enough to have Landsat data from late August 1999, as well as Corona data from circa 1963 and GPS co-ordinates from September 2000. It is hoped that this will allow mapping of several areas of glaciation to measure potential changes with time.

**Submission Date**

We intend to submit the report to the relevant organisations around mid-April 2001. At about the same time the website will go live.
If during the meantime anyone requires further information regarding any aspect of the Expedition please do not hesitate to contact us: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Or

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**APPENDIX 1**
**Proposed Report Structure**

**Report of a Geotraverse from the Turpan Depression to the Northern Flank of the Bogda Shan Range, Xinjiang Autonomous Region, P.R.China.**

**Introduction**
- Origin of the Expedition
- Concept of the Geotraverse
- Structure of the Report
- Objectives of the Project

**The Expedition: Logistics, Materials and Equipment**
- Personnel
- Finance
- Logistical Planning: Collaborative contacts
    - Beijing
    - Urumqi
- Computer (support facilities, batteries etc)
- GPS Instrumentation
- Field Logistics (food, transport, accommodation etc)

**Pre-Expedition Scientific Studies**
- Data Assembly and Processing
    - Landsat
    - Corona
- Pre-expedition Imagery Interpretation
- Itinerary/Fieldwork Planning

**The Expedition**
- Programme, Itinerary, Methodology
- Scientific work in the field
- Image processing/interp/uses
    - GPS use
    - Possible DEM

**Field Science**
- Turfan Basin
- S Flank
- N Flank
- Mobile Studies
- Outcome and Products from Field Programme

**Post-Expedition Lab Studies**

**Objectives and Timetable**

(This will be presented as work in progress or planned for 2000-01 in the Autumn 2000 version of the report.)

**Conclusions**

- Expedition
  - Organization
  - Logistics
  - Recommendations

- Scientific Project Discussion/Review:
  - Field results
  - Lab results
  - Collation with published work
  - Deliverables from the study
    - Methodology
    - Imagery
    - Scientific literature: manuscripts etc
    - Geoscience conclusions

**Acknowledgments**

**Appendices**

Publication manuscripts etc (for final report)

**APPENDIX 2**
**Itinerary**

Thursday 31st August
Advance Party arrive Urumqi after day in Beijing liasing with contacts.

Friday 1st September
Land-cruisers are used by Advance Party (Alex A. and Martin W.) for field reconnaissance along the southern flanks of the Bogda Shan to the base of Sansza Valley.

Saturday 2nd September
Shopping and supply run

Sunday 3rd September
Shopping, airport run to collect the rest of group

Monday 4th September
Drive to Turpan, see Irrigation channels.

Tuesday 5th September
Drive to Aydinghol Lake, GPS coordinate collection and calibration at point of known elevation. Examination of thrusting and rollover anticline structures.

Wednesday 6th September
Visit the Flaming Mountains observe evidence of neotectonics. Drive to Yansanto Hills, and observe palaeo river terraces.

Thursday 7th September
Leave Turpan, second reconnaissance of main valley. Drive through the Nan-Shan, reconnaissance, mobile investigation, GPS data and photographs of the mountains.

Friday 8th September
Leave Urumqi drive to base of glacial valley

Saturday 9th September
Reconnaissance walk to vicinity of glacier, part of the team turns back; Philippa M., and Alex A. continue and see glacier.

Sunday 10th September
Group walk of lower valley to see East-West trending faults, exploited by large-scale glaciation, Investigation of neotectonnic faults believed by the Chinese to be displacing moraines. First evidence of hard volcanic tuffs in the vicinity of bioturbated metasedimentary material. The volcanism is predominantly basic with intermediate events present. This is interbedded with recrystallised quartzite and mudstones. The EW glacier represents a tributary to the main glacier that became stagnant and isolated due to +100 metre build up of lateral moraine.

Monday 11th September
Team splits, Alex A. Joerg H., Alex D. and Philippa M. walk to glacier
Martin W., John McM. And Mark. S. walk to northern East trending valley near major synform. Main valley populated by complex moraine formations. Evidence in large North Eastern valley of large antiformal structure.

Tuesday 12th September
Dan H. and Martin W. walk through northeastern valley to synform, map extent of the ridge. Glacial party, map extent of glacier, with an aim to measuring glacial retreat and lithologies near lateral extent of glacier. All teams return from glacier.

Wednesday 13th September
Philippa M. Alex D. Martin W. and Mark S. walk southerly valley and map parts of the exposed anticlinorium, concentrating on the East side. Team A, Joerg H, Alex A., John McM. And Mark S. return to glacier.

Thursday 14th September
Team A. maps the extent of the glacier, Team B walks north along the Western side of the main valley. More evidence of shallow water marine volcanism as well as limestone and possible fossils. Limestone grades into mudstone up-sequence.

Friday 15th September
Team B. splits to study glacial valleys. Part of team B study the high cliffs observing a change in volcanic regime to a more viscous melt. Investigations in the limestone/mud deposits in the lower valley show possible trace fossil and marine organism assemblages. Team A. returns from glacier.

Saturday 16th September
Main team explores, synform over the ridge of the northeastern valley. Dan H. and Martin W. map river valley north of basecamp, concentrating on northern limb. Evidence of small scale dykes as well as large amorphous bodies of basic igneous material.

Sunday 17th September
Philippa M., Joerg H., Martin W., and Alex D., walk and record the folding on the Western side of the southern valley to the pick up point. Leave base camp midday pick up, drive to Urumqi. Evidence in shallow marine sediments of lava bombs and other explosive volcanics.

Monday 18th September
Resupply in Urumqi

Tuesday 19th September
Drive to Heavenly Lake

Wednesday 20th September
Kazak assisted walk into mountains. Base camp established at confluence of two streams.

Thursday 21st September

Reconnaissance south, up the valley, towards main glacier. Noted increased periglacial geomorphology compared with Southside.

Friday 22nd September
Mapping Front of glacier. Small glacial snout is measured using GPS data to be used in conjunction with Southside data to determine glacial retreat. Alex A., and Joerg H., move to advanced base camp.

Saturday 23rd September
Martin W. Alex D., and Dan H., move up sub-parallel southerly tributary valley to find height of nick point. This will be used in conjunction with the nick point of the main valley to examine down cutting in the region.

Sunday 24th September
Mapping of high outcrops along steep northern slopes out of base camp north to Heavenly Lake. Similar basaltic material to South Side

Monday 25th September
Multiple sub-parallel profiles normal to the river valley are taken to ma the change in the profile shape, to determine where the valley changes from a U to a V shaped valley. Profile is also taken parallel to the river channel to find nick point where river begins cutting down into valley. This will be compared with data on the previous day to see if nick points are at a similar elevation.

Tuesday 26th September
Martin W., Philippa M., P. Mason map northern extent of valley, Eastern side during walk out. Group walks along the edge of Heavenly Lake taking continual GPS measurements. Pick up from Heavenly Lake

Wednesday 27th September
Day off in Urumqi, half party leave

Thursday 28th September
Resupply in Urumqi

Friday 29th September
Joerg H., Alex A. and Martin W., drive to base of Bogda Shan to find evidence of fault controlled drainage identified on the imagery. Local Mining methods are investigated with visits to working coalmines and working limestone/marble extraction.

Saturday 30th September
Major thrusting north of Bogda Shan is explored as well as the neotectonics on flanks due to encroachment of terrains over surrounding Junggar Basin.

Sunday 1st October
Report writing