LAGUNA PARON EXPEDITION

PERU

THE LAGUNA PARON EXPEDITION, PERU, 1987

PERSONNEL

Jonathan Marsh

Hamish Osborn

Nigel Hollett

Martin Putnam

Christopher Martin

INTRODUCTION.

Peru is a developing country currently experiencing a period of relative economic growth. However many problems exist such as political instability, a tremendous inequality in wealth between different cultural groups, and a large foreign debt. In addition, major natural disasters frequently occur particularly in the mountain provinces causing extensive loss of life and substantial damage to property. For example, in May 1970 the most catastrophic western hemisphere earthquake in recorded history triggered thousands of landslides that devastated the Callejon de Huaylas (valley of the upper Santa River) of central Peru, killing 80,000 people. 15,000 people died when the town of Yungay was engulfed by a huge mud flow initiated by the collapse of the summit of Huascaran. This mountain (6768m)is the highest in the Cordillera Blanca, a narrow but high range of mountains, orientated in a north-south line and contain -ing the greatest concentration of glaciers in the tropics.

Following the 1970 catastrophe the Peruvian Electricity Generating Board (Hydrandina SA) and others undertook studies in this region to try to assess the stability of various areas within the Cordillera Blanca. One such area was the upper Paron valley, 20 kilometres north east of the town Caraz.

In the upper Paron valley a 300 high glacier filled moraine, Hatanraju, has dammed the higner reaches of the valley causing a lake (Laguna Paron) to form. Following the 1970 disaster it was feared that in the event of another major earthquake this moraine dam might fail thus releasing water, mud and rock debris down the Paron valley potentially destroying the sizeable town of Caraz.

The Laguna Paron expedition set out intending to do some research work in the upper Paron valley. It was hoped that we could do work in close conjunction with, and of relevance to, the ongoing studies of Hydrandina SA. In the early

1980's Hydrandina SA. built a 1.5 kilometre tunnel from Laguna Paron to below Hatunraju as a safety measure, the Laguna was subsequently drained by about 75% water volume until the stability and safety of Hatunraju could be firmly established. Laguna Paron remains at this substantially lower level today.

The lowering of the lake level has obviously resulted in major changes to the Laguna and its surroundings. Using limnological techniques we hoped to study the extent of these changes whilst updating studies done on the lake before it was drained. We also planned to undertake a survey of the moraine Hatunraju, examining its structure and stability using geological and geomorphological methods. Jonathan Marsh and Hamish Osborn used this field work as the basis of their undergraduate degree level projects. The expedition team spent five weeks in the field.

GENERAL.

Supplies of food were obtained principally from local markets and shops in Huaraz. Frequent journeys were made by Hirandina SA from their offices in Huaraz to their Campiamento 1 kilometre from our refugio. Resupply was straight forward and food costs while at Laguna Paron were reasonable.

Cooking was done predominantly on Primus stoves. Paraffin is readily available in Peru unlike methylated spirits which is virtually impossible to obtain. Primus stoves functioned well at 4000m and spare parts were available in Huaraz. The refugio did have a water supply but its quality was suspect and every effort was made to boil water beforeconsumption.

The expedition had adequate first aid equipment and fully qualified help could easily be reached from the fieldwork site. Hidrandina SA had radio contact with their campiamento at Laguna Paron. One expedition member developed an abcess in his mouth and was immediately able to travel to Huaraz for dental treatment.

CLIMBING AND TRAVEL IN PERU AND ECUADOR.

Priority was given to completing the proposed work. On its completion poor weather set in. In early September an attempt by J.Marsh and M.Putnam on the south west face of Artesanraju (6025m) was abandoned following heavy snowfall. Prior to this J.Marsh and an American climber attempted a potential new route on the north face of Pisco Este (5800m). They had to retreat on reaching 5600m because of time restrictions.

In addition to carrying out the fieldwork expedition members managed several weeks travelling in Peru and Ecuador. During this time attempts were made at climbing Cotopaxi (5897m) and Tunguraha (5016m) both in Ecuador. Neither summit was reached although time spent on both volcanoes was very interesting and served to acclimatise expedition members. Travel in Peru and Ecuador was very worthwhile and greatly assisted by using various travel guides for South America. For example, South America on a Shoestring.

ADMINISTRATIVE AND LOGISTICAL REPORT.

Planning

The expedition destination was decided on one and a half years prior to departure. Some research and correspondance confirmed the Cordillera Blanca as a good potential site for scientific study. One year before the expedition Hamish Osborn visited the area and contacted Senor Alcides Armes, Glaciologist Engineer with Hidrandina SA (Peruvian Electricity Generating Board). In conjunction with Senor Armes and Dr. John Reynolds, lecturer in Geophysics at Plymouth Polytechnic, Scientific research projects were planned. Hirandina promised as much help as possible on our arrival given their very restrictive budget.

Fund-raising

The Royal Geographical Society and Mount Everest Foundation gave the expediti-on their support. We asked Chris Bonnington to act as expedition Patron. As an expedition we hoped to raise two thirds of the total cost (originally estimated at £1260 per person) through sponsorship, grants and donations. In addition to the cost of personal gear each expedition member would pay one third of the cost himself.

Fundraising began in December 1986. We tried to get sponsorship both as a group and as individuals. No real support was received until after Easter 1987.

SUMMARY OF EXPENDITURE AND INCOME.

The Explorers club	£660
Royal Geographical Society	£100
Mount Everest Foundation	£300
Gilchrist Educational Trust	£300
Anglo-Peruvian Society	£350
Wingrove and Rodgers	£100
Union Carbide	£100
Gilbert, Gilkes and Gordon	£ 50
Frank Davies (the climbers shop)	£ 50

Sponsored Beach Tidy	£300
TOTAL	£2310

Other help

Gore-Tex Fabrics - donation of goretex fabric

Mountain Method - manufacture of cost price waterproofs

Schwart Spices - spice kits and raffle prize

Parkin International Processed foods - many cook in the container meals

The Climbers Shop Ambleside - 25% discount on purchased equipment

Expenditure per person

Airflight from London to Lima return	£520
Transport in the U.K.	£ 20
Transport in Peru	£ 40
Living costs	£200
Insurance	£126
Additional Expenditure	£ 70
	£976
Total cost of the expedition	£3904
Money raised	£2310

Expedition members made up the difference.

Travel and Transport

To and from Peru. Economy class with Viasa. No baggage restrictions on the outward flight but an unexpected 20Kg limit on return to the U.K. Although we were all well over our limit no excess baggage charge was levied.

Transport in Peru. Local bus services were predominantly used, these were usually overcrowded but normally reliable . Constant care had to be taken to avoid theft of equipment, particularly at bus terminals.

PERSONNEL.

Jonathan Marsh — Expedition Coordinator

Age: 22 years

Address: 11 Ashmeadow Rd, Nether Kellet, Carnforth, Lancs, LA6 1EN
Tel- 0524 733675

Occupation; Third year Ocean Science and Geology student Bsc.(Hons) at Plymouth Polytechnic.

Experience: British Schools Exploring Society (B.S.E.S.) 1984 Arctic Norway Scientific and Moutaineering Expedition, Young Explorers Trust (Y.E.T.), Youth leadership training course 3 Alpine climbing seasons.

Hamish Osborn

Age: 21 years

Occupation; Third year Geology and Geography, Bsc. (Hons) at Plymouth Polytechnic.

Experience: 1984-5 Instructor at Outdoor Pursuits centre in S.Wales. 1985 Operation Raleigh Scientific and Mountaineering Expedition to Chile.1986 3 months in Peru and Ecuador.

Nigel Hollett

Age: 21 years

Occupation; Third year Mathematics and Physics Bsc. (Hons) at Plymouth Polytechnic.

Experience: Duke of Edinburgh Award Scheme (Gold), B.S.E.S. 1985 Alaskan Scientific and Mountaineering Expedition.

Martin Putnam

Age: 23 years

Occupation: Outward Bound Instructor. Graduated from Plymouth Polytech -nic 1986. Bsc (Hons) Environmental Science.

Experience: Instructing at Outward Bound Centres in Lesotho and North America.

Christopher Martin

Age: 24 years.

Occupation: Graduated from University of East Anglia, Norwich 1987. Bsc (Hons) Environmental Sciences.

Experience: Extensive travel experience in wilderness areas of Africa, Indonesia, and Australia.

Note: Separate list of sponsors as follows:- STA Travel, Watermayer, Banbury Charities, Banbury Round Table, Alcan International, Hawker Siddeley Water Engineering, Countrywide Publicity, and Demag. Blinkhorns Photographic provided photographic equipment and The Banbury Guardian ensured wider publicity in the local area with a short column about the expedition.

LOGISTICS AND FIELDWORK AT LAGUNA PARON.

On arival in the Cordillera Blanca the expedition was greatly assisted by Hidrandina SA.

They provided:

i).Transport to and from Laguna Paron.

ii).A refugio for our accomodation and use whilst in the field.

iii).Access to all their ongoing studies on the area.

iv).A boat and outboard motor for use on the Laguna.

v).Any equipment needed that they had available.

vi).Everyday work needs (fuel, lamps).

The refugio at Paron is at an altitude of 4000m. Living at this altitude presented no real problems. Intermittent illness, sometimes very debilitating did effect every individual on occasion. The cause of this was never established.

RESEARCH WORK.

Hydrography.

At least two people were needed at any one time for work on and around the laguna. Catabatic winds during the day often made work in the boat very difficult after 10.00 am. At this altitude, on a parrafin/petrol mix, work was hindered by the motor inefficiency, this caused several delays during the five weeks in the field. Most of the specialist equipment taken functioned adequately and all the planned work on the Laguna was completed successfully.

Geomorphology.

The altitude made work on the moraine quite strenous. The very loose and unstable nature of the moraine debris meant that two people had to be on the moraine at any one time for safety. Observations were made right up the length of Hatunraju although only the lower one third of the moraine was extensively studied. Instability and danger increased further up the moraine as one approached the Huandoy Massif.

HYDROGRAPHY

Standard limnological methods were employed to deduce the hydrography of this high altitude proglacial lake. The conclusions presented here focus on the thermal and suspended sediment character of the water column along with the density current regime and flushing time of the lake over a five week period. Accurate recording of the bathymetry was essential.

Conclusions.

(i).Redistribution of old exposed lacustrine sediments, both distally and laterally is evident from the bathymetry. Coriolis deflection of inflowing river water increases sedimentation rates down the southern shore.

(ii).Insolation rises and temperature falls as a function of increasing elevation caused by the low continentality of the climate in the Soutnern Hemisphere.

(iii).Suspended sediments in the lake water increase the albedo, limiting the penetration of heat to surface waters. Cold unidirectional winds mix the shallow surface water effectively, preventing the development of thermal stratification in the water column.

(iv).Delta growth accounts for 99.8% of annual sediment deposition, indicating that the lake is a sediment trap. The present high sedimentation rate (2x10 m /year) indicates that the lake will be totally silted in 10 years. However the source of these sediments, the old lake bed, is limited.

(v).The lake is a cold polymorphic low energy high sediment type, with a highly isopycnal and isothermal water column and has a density current regime in the form of underflows.

(vi). The flushing time of the lake is approximately 236 days and is therefore ideally suited to act as a reservoir for hydroelectricity. In the light of the heavy silting and possible carcinogenic colloids it is recommended that the lake level be raised from its controlled and reduced level by 20 metres. This would allow settling of fine sediments, perhaps restoring the original translucent blue colour of the lake. Increasing the hydrostatic head on the damming (and possibly unstable) moraine may be unadvisable considering past disasters.

GEOMORPHOLOGY.

From fieldwork it can be concluded that Hatunraju has a glacial karst topography, developed because the glacier has a low ground water level, the ice is moving slowly with little deformation, there is a sufficient supply of englacial water and it's surface is covered by a thick mantle of supra glacial debris. These characteristics promote the dominance of englacial over supraglacial melting so that surface topography of the glacier is controlled from below.

The supraglacial debris has also had the effect of preserving the glacier ice, thus Hatunraju extends lower into the Paron Valley than any of the other glaciers in Paron. The debris is derived from the cliffs of Huandoy Este and Norte which are situated above and on either side of the accumulation zone.

High water levels within the glacier system are considered to be a product of high rainfall and ablation in the wetter months, i.e. September to March. A large supraglacial lake was situated on the upper area of the glacier. It has been suggested that this lake (name Hatunraju for the purposes of this project) was formed due to the collapse of an englacial cavern and that it could possibly present stability problems in future years. If it becomes sufficiently large for the lake to come into contact with the moraine, water would be released from the lake which could cause a washout in the moraine or a failure of the moraine slope, due to increased pore water pressures. Either would result in much debris being being shed down the slope towards the Paron campiomento where several Hidrandina personel are housed. At worst it could contribute to the failure of the moraine as a whole, particularly if the lake reaches the base of the glacier and the water enters the "basal" moraine. For this reason it is recommended that the progress of Laguna Hatunraju is carefully monitored.

The appearence of the lake illustrates that dispite the slow movement Hatunraju is an active system which should not be dismissed as stagnant ice. The formation of the crooked tongue of the moraine is considered to be due to the deformation down hill of an unconsolidated base in the middle of Paron valley, onto which the glacier advanced. The downward movement of the glacier tongue on the sediment, relative to the stationary (in an E-W direction) upper

glacier, resulted in the ninety degree turn.

The movement of Hatunraju is thought to be due to creep within the basal moraine due to the presence of intestial clays. Indeed highly plastic clays were found on Hatunraju which, it is suggested could be similar to those within the glaciers deformable base. The deformable bed theory of glacier movement is becoming more acceptable in glaciological literature in recent years.

Much futher work will be needed on Hatunraju before this interesting and unusual feature is properly known and understood.

VEGETATION AND SOIL STUDIES.

From a sampling area consisting of the soutnern most section of the dry lake bed plus the west moraine plants were photographed and subsequently identified. Plants could be divided into two groups, group A occuring between 4100m and 4200m and group B growing above 4200m.

Group B plants are therefore more able to withstand greater exposure and a thinner soil. Approximately 50% of the moraine is vegetated between 4100m and 4200m. This figure falls to 20% between 4200m and4300m, and subsequently to 0.5% thereafter at 4350m. There is a notable absence of vegetation on areas of the moraine which are'unstable'.

Group 1.

ANGIOSPERMS; ASTERACEAE Inulae (Tribu), BROMELIACEAE Puya sp. ? , ERICACEAE Pernettya prostrata, CACTACEAE Opuntia floccosa, LILIACEAE Bomarea dulcis, ORCHIDIACEAE ?, POACEAE Calamagrostis sp. ?, POLYGONACEAE Muehlenbeckia volanica SCROPHULARIACEAE Bartsia sp. ?, GYMNOSPERMS;EPHEDRACEAE Ephedra americana.

Group 2.

ANGIOSPERMS; CACTACEAE Opuntia floccosa, ERICACEAE Pernettya prestrata, LIDACEAE Bromarea dulcis, ASTERACEA Baccharis sp. ? , LEGUMINOCEAE Lupinus sp. ?, POACEAE ? , POLYGONACEAE Muehlenbeckia volcanica, ROSACEAE Polylepis sp. ?, PTERIDOPHYTES; DRYOPTERIDACEAE Elaphoglossum sp. ?.

SOILS

The soils sampled at Laguna Paron may be classified as Entisols (soils without pedogenic horizons) The parent material is Granodiorite. The sub class is Orthents (loamy or clayey textures plus shallow profiles over rock) This sub group is characteristic of the Peruvian Andes. Profiles were typically fine textured, varied considerably over small distances, normally exhibited an iron and alluminium sesquioxide pan between 20 and 100cm and may demonstrate a semi-mobile 'C'horizon which partly explains the instability of certain micro-regions.

ACKNOWLEDGEMENTS

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We are also extremely grateful to the following without whose help nothing would have been possible:

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The Gilchrist Educational Trust
Anglo-Peruvian Society
Wingrove and Rodgers
Union Carbide
Gilbert , Gilkes and Gordon
Frank Davies and The Climbers Shop,Ambleside
Gore-tex Fabrics
Mountain Method
Parkin International Processed Foods
Schwartz Spices
Bucon Microstore ltd., Swansea

We would also like to thank the following for their assistance in the scientific work and administration: Dr G Millward, Dr A Gellatly, Dr P O'Sullivan, Dr J Reynolds, Claire Marsh and Kate Lock.

Thanks to anyone else missed out.

CONCLUSION

In general the expedition went very well. Its small scale minimised possible travel problems and kept costs to a minimum. Because of the reconnai -ssance visit one year before by an expedition member there were no unfereseen practical difficulties. Research work done at Laguna Paron has formed the basis of degree level theses for J Marsh and H Osborn. We hope that some of the research work and findings will be of use to Hidrandina SA in their ongoing work on Hatunraju and Laguna Paron. There is much scope for further study in this area and it is likely that this expedition will be followed by others from Plymouth Polytechnic. The link created with Hidrandina SA can continue to be mutually beneficial.