High-Altitude Research Atop Canada's Highest Peak

JOSEPH C. LABELLE
Assisted by Charles S. Houston, M.D.

In 1967 the Arctic Institute established a high-altitude research station on Mount Logan and began a long-range study of high-altitude physiology, associated with research in glaciology, climatology, and geology. The project was a logical extension of ten years of ecological research based on Kluane Lake in the Yukon Territory close by the Alaskan border.

Mount Logan (19,850 feet) is ideally suited for such a research facility. Its summit plateau – one of the largest high-mountain masses in the world – consists of a huge snowfield four or five miles long and two to three miles wide. This smooth bowl is surrounded by the peaks of the Logan massif, and falls from 18,000 to 16,000 feet, where the snow, compressed into glacier, cascades over the enormous rock cliffs. The bowl is almost free of crevasses and thus ideal for aircraft landings and for a sprawling encampment.

Planning began in the fall of 1966, and during June and July of the following year Barry C. Bishop of Everest fame led the climbing party which would build the laboratory. The six climbers were airlifted into King Trench at about 10,000 feet and climbed the west-buttress route to the summit plateau, dropping into the huge snowbowl at the planned site at about 17,500 feet. The plywood building had been carefully pre-cut so that it could be flown up in segments in the helio-courier STOL aircraft. Phil Upton, one of the most experienced high-altitude flyers in the world, made 27 landings and takeoffs during the two summer months despite unusually severe snowstorms and wind. Bishop's party completed the laboratory in spite of a series of mishaps, but none of the physiological studies, which were probably overambitious for the first year, could be completed. However, this pioneering venture clearly established the feasibility of this site for research (*A.A.J.*, 1968, 16:1, p 157).

The very next spring an overflight showed that the laboratory had been completely buried, and even the long poles which marked its roof had

disappeared. Despite the problems which this presented, Jim Underwood led Del Smith and King Seegar and me up from the landing area in King Trench onto the summit plateau. Seegar became seriously ill from the altitude upon arrival, and was airlifted out to Whitehorse Hospital where he made a complete and rapid recovery. Underwood, Smith, and I spent three days with avalanche probes before we located the hut and tunneled down into it. Charles Keeler and his associates from the Army Cold Regions Research and Engineering Laboratory (CRREL) were very helpful to us; both parties lived in mountain tents during this search. The laboratory was buried under 14 feet of accumulated snow, and some of the rafters were bowed under the weight.

We immediately began the meteorologic and glaciologic observations, and in early July welcomed the physiologists. Drs. Charles Houston, Charles Bryan, and John Cocker, two laboratory technicians and eight Canadian Armed Forces volunteers were taxied back and forth to the laboratory by our superb pilot Phil Upton. The weather was much better in 1968, and Phil was able to follow quite closely the prearranged schedule. The physiologists demonstrated that they could easily and accurately use their sophisticated equipment, and they made a number of important studies preliminary to the more detailed work planned for 1969. The laboratory was firmly established, safe, comfortable, and had proven its feasibility.

Although a great deal of research was done throughout the summer, there was still time for several ascents. The climbing party and some of the volunteers climbed nine of Mt. Logan's scattered peaks, some of them for the first time. Two of the party (Seegar and one of the doctors) were found to have hemorrhages in the back of the eye, an unusual observation which would lead the research in new directions the following year.

Our camp was closed in August. The scientific team flew off the mountain, while the climbers crossed the western plateau, descended the couloir on the south side of the west buttress next to Queen Peak and were picked up at 10,000 feet by our indefatigable pilot. (*Canadian Alpine Journal,* 1969, and *A.A.J.,* 1969, 16:2, pp 404-5).

By the end of 1968 it was quite clear that the Mount Logan high-altitude laboratory was unique among research facilities in the world, and that already certain observations had been made which had never been reported before. There is a world of difference between 17,500 feet and the usual altitudes for scientific research – 14,000 to 14,500 feet. The scientists were fortunate in receiving a grant from the Max C. Fleischmann Foundation in the fall of 1968, which enabled the party to assemble, train together, and plan carefully for 1969.

I had a lot of people to choose from, and it was not easy to pick the team. Dr. Houston, in charge of the scientific projects, gave me full leadership for the support party, and I chose some old friends and some new ones: my deputy Tom Lyman, another old climbing buddy Casey Stengle, geologist-climber A. J. LaFleur, two college students, Nick Rosenblum and Pete Fletcher, and last and perhaps most important two delightful girls, Carol Harden from Middlebury and Jenny Cook from Wellesley. It turned out to be an unusually harmonious and competent group, and it is fair to say that they were absolutely essential to the scientific successes which were to follow.

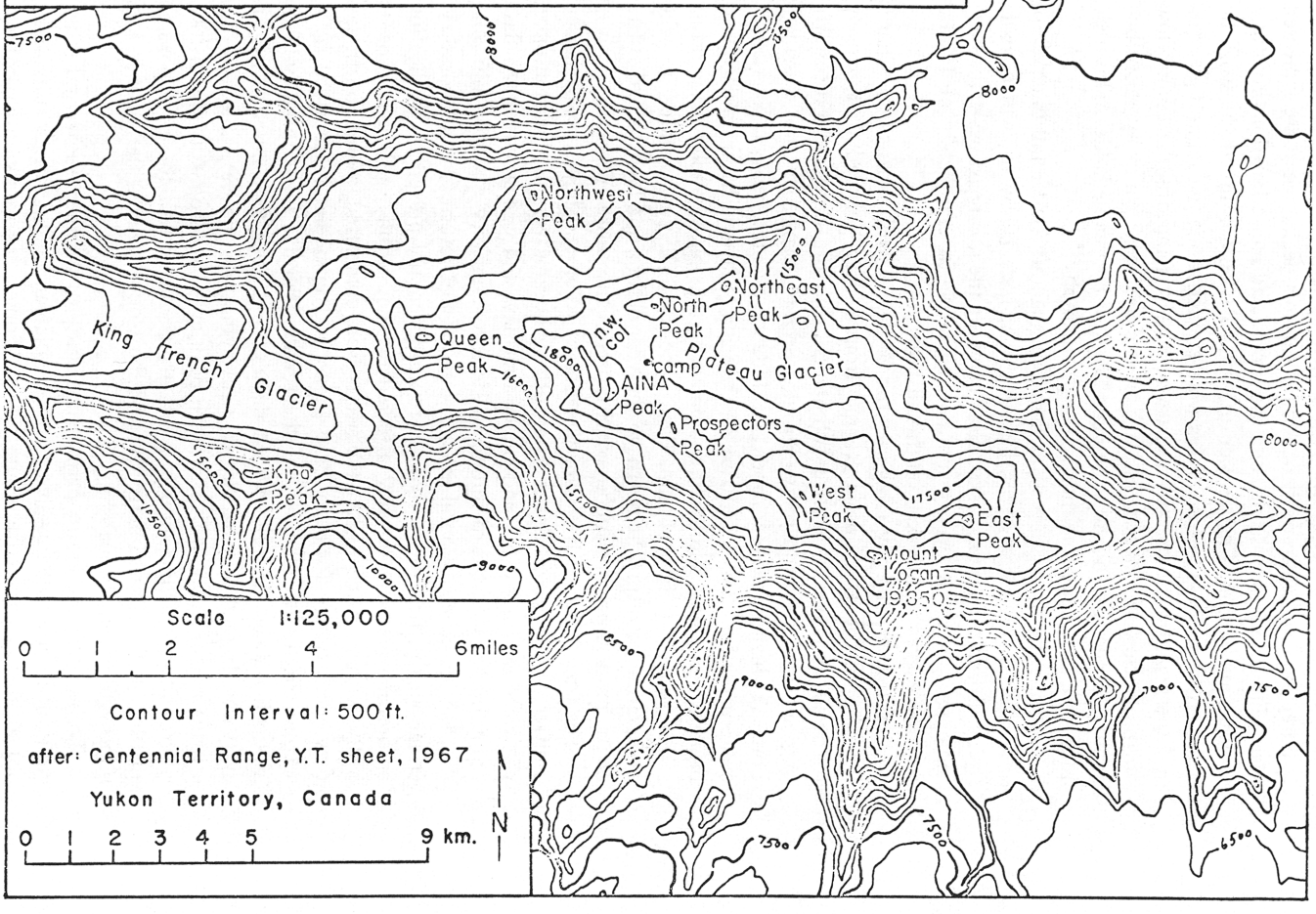
An initial overflight showed that the new poles were still visible, and six of the support party flew to King Trench in early June and after an initial storm climbed slowly up to the laboratory in beautiful weather. On June 14 we reached the laboratory site, and found tattered flags still flying from the poles. The laboratory was still deeply buried, but the reinforcements we had placed on the rafters held strong. We had already decided to use the old laboratory for the generator and for storage but to live and conduct our research in two new portable shelters, which could also be flown up in pieces from Base Camp and easily assembled. The Versadome hut is a modified geodesic skeleton of bolted steel tubing, with a double nylon skin, and a plywood floor. A small propane space heater is all that is needed to make this tight and well insulated hut quite comfortable even at cold temperatures, and it is spacious and well lighted. We used one as the medical and research hut, while the others served as eating, sleeping and living quarters for eight people!

While putting up the Versadomes we lived in mountain tents, where we welcomed the frequent visitations from Phil Upton. One night he brought in a cooked turkey dinner complete with fresh bread, salad, stuffing, and sweet potatoes! Phil's landings and takeoffs became routine. Our work proceeded rapidly in excellent weather. But trouble was never far away as we learned when Phil landed one day on soft snow, hit some hidden icy sastrugi, broke his tail ski and splayed out the main landing skis. Somehow he repaired the damage enough to takeoff, but it was a useful lesson: thereafter he landed downhill from the hut where there were no sastrugi.

By the end of June the hut had been cleaned and reinforced, the generator installed, and we were on regular single-sideband short-wave radio communication with Base Camp – which usually was almost as good as telephone service. All of the meteorological equipment was brought in and the weather station set up, and we began reporting every three hours around the clock. A recording thermometer left during the winter had stuck at –110°F.

Our glaciological studies were also begun, and – to our pleasure –

Figure 2. MASSIF of MOUNT LOGAN, YUKON TERR.



required that we climb most of Mount Logan's peaks, where we collected rock samples when possible, dug snow pits, and chose locations to study snow accumulation. Charles Keeler from CRREL continued the work he had started the year before. Poles were erected along the summit glaciers, and these will be frequently resurveyed to determine strain rates and flow of the glacier. We investigated a large crevasse near camp by rappelling about 100 feet down into it and climbing out by a cable ladder. This little adventure provided some spectacular photographs.

In late June forest fires were raging throughout Alaska and the Yukon, and there was an almost continuous smoke-haze below us, which made flying difficult. One day, as we were climbing the northeast peak, the haze came up for about twenty minutes, engulfing us completely at 18,000 feet. We gagged and choked on this air pollution.

On July 5 the physiological studies began with a bang. Dr. Charles Bryan and Dr. Drummond Rennie from Chicago arrived first, closely followed by a batch of five volunteers from the Canadian Forces. We received a large airdrop by Buffalo aircraft, loaned by the Canadian Forces, which provided food and lodging for the troops, as well as equipment for the scientists. Dr. Regina Frayzer from Indianapolis brought along 400 pounds of equipment to take photographs of the retina of everyone at High Camp. This special work was dictated by the observation of retinal hemorrhage the year before, and later turned out to be the most important and innovative part of the entire program.

The first group of five Canadian Forces volunteer subjects experienced a different degrees of illness. Their officer became very ill almost at once, was unconscious by the end of the first day, and was evacuated to Base Camp by Dr. Houston at midnight. He recovered very quickly from what the doctors called cerebral edema, but did not return to the laboratory. Others in this first group (who were not given any preventive medication before arrival) were severely affected by the altitude, although none as badly as their officer. After their tests were completed, on the fourth day they were flown down to Base Camp and immediately replaced by a second batch, five members of the Princess Patricia Light Infantry. This group had been pretreated with diamox and were very much better in everyway. In fact, they had scarcely any symptoms and were able to set up a firing range, and – with the north peak as a backdrop – to fire pistols, rifles, and submachine guns in a test of performance of these weapons at altitude. It functioned perfectly, and the troops claimed the altitude had improved their marksmanship.

Throughout the entire period, our study of weather, snow, and rocks continued. Often we travelled across the plateau and up various summits – not at all unpleasant for mountaineers. Sometimes we skied back down through deep powder, or slid down on the toboggans which had been used

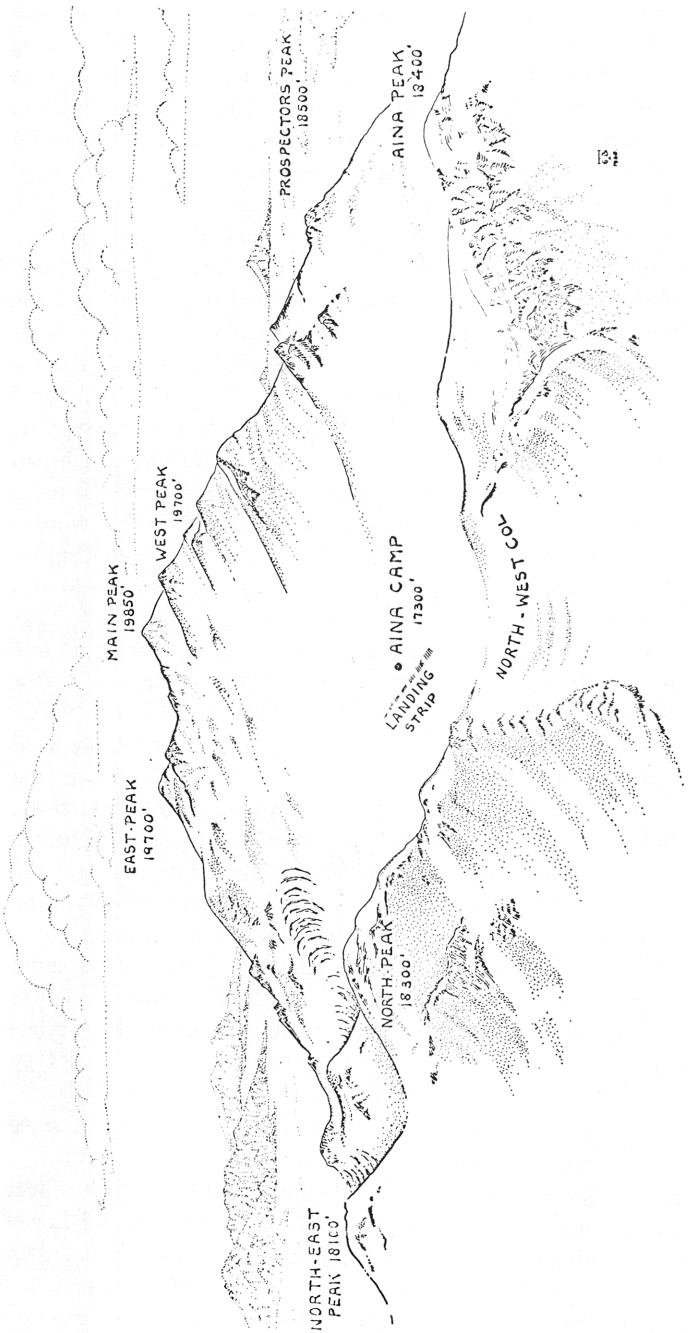
to haul the parachute loads. Evenings were usually spent around the space heater, swapping lies, singing bawdy songs or sharing in the evening medical report on the radio. This became an important ritual: the support doctor who was always at Base Camp used this half hour of conversation to make some assessment of the condition of the doctor at High Camp and his troops, listening not only to what he said, but to how he said it as well.

By late July the research and military programs were over. The volunteers and scientists flew off the mountain, and the support party closed camp and headed for the summit of Logan several miles away and half a mile above us. We crossed the plateau, skirted the shoulder of the west peak, and camped at 18,500 feet on a spectacular rock knob. Early on July 23 we shouldered light packs and headed across the eastern plateau glacier and up the final summit slopes. At four P.M. Carol and I reached the top, followed in a few minutes by all the rest of the support party. We planted our small flags next to a very colorful one which had been left earlier in the summer by a Japanese party, and took the usual photographs. Carol Harden and Jenny Cook thus became the first women ever to climb Logan, and we celebrated this momentous event appropriately. We hurried down to camp, stopping only at the nearest outcrop to collect a few rock samples. A raging storm kept us in camp the next day, but by noon on July 25 we started down, reaching the laboratory late in the evening. We spent the next few days getting everything in order for the winter, somewhat hampered by almost continuous snow. The Versa-domes were taken down and cached on top of the old hut while we lived in tents. Finally on August 2 in deep new snow we walked over the 18,000-foot pass above the laboratory and down to 13,000 feet seven hours later. Since it is dark for only a few hours in the middle of night, we got an early start and met Phil, whom we had contacted by radio, at the King Trench landing site. The backup pilot, Roger Eisinger, arrived in the second plane, and by noon the whole party was safely back at Base.

It was a most productive and exciting summer; good friends, good climbing, and good research accomplished. The scientific work will take some time to analyze, and will eventually be published in the appropriate journals. Since mountaineers are particularly interested in the physiology of high altitude, a short note describing our observations follows.

For 1969 we had planned five major research projects, using the same experimental subjects and interweaving all of the work.

The kidney studies, conducted by Dr. Rennie, required that we collect all urine excreted in twelve-hour periods both at Base Camp and Logan High Camp. Elaborate analysis of urine components is being conducted on specimens taken back to Chicago. The "sieving action" of the kidney was measured by injecting a special material (PVP) intravenously, and examining the urine to measure the amount and the size of the molecules secreted


PROSPECTORS PEAK
18500'
AINA PEAK
18400'
MAIN PEAK
19850'
WEST PEAK
19700'
AINA CAMP
17300'
LANDING
STRIP
NORTH-WEST COL
EAST PEAK
19700'
NORTH PEAK
18300'
NORTH-EAST
PEAK 18100'

in the urine. This is a very sophisticated and elaborate study, and the analysis of urine and blood samples will take the full time of one technician for more than six months!

Dr. Charles Bryan had been experimenting with a simple method for measuring cerebral blood flow, previously described by others. By ingeniously using a special scuba mask, a blood pressure cuff around the neck and a pressure recorder, he was able to measure the arterial flow to the brain reasonably accurately, the first such observations made at altitude. All we were able to do in 1969 was to determine that this technique was valid at altitude; next year we plan to make the studies more complete.

The unusual retinal pathology which was observed for the first time in 1968 led us to make further studies a high priority item. Although retinal photography is a demanding task, Dr. Frayzer was able to take retinal photographs of almost everyone in the party at High Camp, and of all the scientists and volunteer subjects at Base Camp as well. She also measured the capillary permeability in the retina, and her observations will correlate with similar observations made on the kidney.

To our astonishment we found that nine out of 25 people who went to high altitude showed hemorrhaging in the retina. Only one had symptoms. In other words, if we had not been looking for these hemorrhages, only one of the nine persons would have known they existed. Just why hemorrhages occur, and why they occurred in the acclimatized subjects as well as those who flew up rapidly from base camp, is not known. But this is an important new observation, and will be extensively pursued.

Earlier work on Logan and by others elsewhere had clearly established that Diamox has protective effect against mountain sickness. Five of the Canadian Forces volunteers were therefore given Diamox before ascent and remained relatively symptom-free despite their rapid ascent. The other group of five Canadian Forces volunteers did not receive Diamox but were given Lasix after arrival at High Camp, a compound which is said by others to have some beneficial effect. We did not find it helpful, and indeed both theoretically and from practical observation we think it may have been harmful. Although the number of people studied is small, and our measurements imprecise, we are satisfied that Diamox does protect against mountain sickness, while Lasix does not.

Clinical observations were made twice daily on everyone at High Camp by Dr. Gary Gray, also from the Canadian Forces, who took care of the health of the party. Although nothing startling was found, we recognized once again that dehydration is a serious and major problem at high altitude. It requires unusual efforts to maintain a high fluid intake. Although we did not measure it, we agree with others that important fluid shifts within the body contribute significantly to the symptoms of high-altitude mountain sickness.

We also confirmed the observations of others that physical fitness is no predictor of success in adjustment to altitude. Apprehension does seem to increase, and high group morale to decrease, the symptoms of mountain sickness, which is well known to be a highly subjective and emotionally influenced condition.

In 1969 we had only one serious episode: the case of unconsciousness in one of the Canadian Forces volunteers. We attribute this to cerebral edema due directly to altitude; the rapid complete recovery seems to confirm our diagnosis. Cerebral edema at this altitude is not rare, and like pulmonary edema (which we have not seen on Mount Logan) constitutes a serious threat to those who go very high very rapidly. In 1968 King Seegar had a milder episode of the same type.

The support party, landing at 10,000 and climbing slowly to 17,500 feet is not exposed to any more hazard than is any ordinary mountaineering party. Nevertheless it is of interest that several of these developed retinal hemorrhage at the laboratory. Far more serious is the plight of those who fly from Base Camp (2000 feet) to the laboratory (17,500 feet) in 40 or 50 minutes. From the very beginning we have recognized the potential dangers in such rapid ascent. The party is protected as much as possible by the immediate availability of at least ten man-days of oxygen in the laboratory. We also require that one physician be at High Camp at all times, backed up by an experienced high-altitude physician at Base Camp, with at least two radios for communication. Obviously a complete medical kit is available both at High Camp and Base Camp, and an excellent hospital at White Horse is within two hours of flying time from Base Camp or the High Laboratory. As our experience with weather and high-altitude aircraft landings has increased, we are quite confident of our ability to handle most predictable problems with safety.

The great advantage of the Logan laboratory is of course that it is the highest laboratory in the world and can be easily reached by aircraft from a well established Base Camp. A vast amount of work has been done at 14,000 feet, together with a good deal of clinical observation at much higher altitudes. We know that each thousand feet of altitude produces a very much larger pathologic response. The Logan Laboratory opens up an entirely new area for scientific research. If we ever are able to do so, we have access to laboratory locations as high as 19,000 feet, reached by snow vehicle from the main laboratory.

We hope very much to join forces with other scientists who are working at lower altitudes, so that eventually we may establish a unique series of laboratories and perform coordinated research in the life sciences and physical sciences.