Ground Combat at High Altitude

by Mr. Lester W. Grau, FMSO, and
Lieutenant Colonel Hernán Vázquez, Argentine Army

This article appeared in

Military Review

January-February 2002

A general who allows himself to be decisively defeated in an extended mountain position deserves to be court-martialed.

-Carl von Clausewitz[1]

High mountain terrain is often inacces-sible, uninhabitable or of no apparent value, yet peoples and states still fight to possess it. Long, bloody wars have been fought, and are being fought, for mountain real estate located between 10,000 and 23,000 feet [3050 and 7015 meters]. Over the past fifty years, high-altitude combat has raged in Africa, Asia, and South America. The Chinese invaded Tibet in 1953 and fought a subsequent guerrilla war there until 1974. From 1953 to 1958, British troops fought Mau-Mau separatists in the Aberdares Mountains of Kenya. In 1962, China and India battled in the Himalayan Mountains bordering Bhutan and Tibet. Soviets fought Afghan Mujahideen in the towering Hindu Kush Mountains from 1979 to 1989. The Peruvian government hunted the Sendero Luminoso guerrillas in the Andes Mountains throughout the 1980s. India and Pakistan have continually battled for possession of the Siachen Glacier since April 1984 and fight sporadically over disputed Kashmir as they have since 1948. Today, Colombia's government troops are fighting the Revolutionary Armed Forces of Colombia (FARC), and the National Liberation Army (ELN) guerrillas high in the Andes, and Russian soldiers are fighting Chechen separatists high in the Caucasus Mountains.

The U.S. Army has no experience fighting in truly high mountains and its mountain warfare manuals deal primarily with low and medium mountains and stress the use of helicopter aviation to conduct that combat. However, helicopters cannot haul normal loads over 13,000 feet [3965 meters] since their rotors lack thick enough air to "bite" into, and high altitude weather conditions will frequently shut down flying for days. High-altitude combat differs from medium- and low-mountain altitude combat and requires a different orientation and force structure. Other armies have experience in truly high mountains and can provide valuable guidance and expertise.

The U.S. Army needs to know how to conduct high-altitude mountain warfare, develop the tactics, techniques, and procedures to do so, and share the experience of other armies to understand and prepare for possible high-altitude conflicts.

The Environment

Mountains are generally classified as low (600 to 1500 meters), medium (from 1500 to 3500 meters) and high-altitude mountains (above 3600 meters). The world's highest mountains are not in the United States, Europe, or Korea-where the U.S. Army is accustomed to working. The Himalayan Mountain chains of Asia stretches 1,500 miles and contains 9 of the world's 10 highest peaks. The Hindu Kush/Karakoram mountain chain of Asia stretches well over 500 miles with its highest peak at 28,250 feet [8,616 meters]. The South American Andes stretches over 5,000 miles and rise above 22,000 feet [6,710 meters] at many points. The Caucasus Mountains, which divide Europe and Asia, run some 700 miles with many peaks over 15,000 feet [4572 meters]. The Himalayan Mount Everest towers at 29,028 feet [8,853.5 meters] whereas the highest point in the United States, Mount McKinley in Alaska, is 20,320 feet [6,197.6 meters]. The highest point in the Colorado Rockies is Mount Elbert at 14,433 feet [4,402.1 meters]. The highest point in the European Alps is Mont Blanc at 15,771 feet [4,810.2 meters].[2]

Although high mountains occupy a good portion of the earth's surface, man is not naturally designed to live and work at these high altitudes. When a person travels to an altitude of 8,000 to10,000 feet [2440 to 3050 meters] or higher, the atmospheric changes in pressure and available oxygen cause physiological changes, which attempt to ensure that the body gets enough oxygen.[3] These physiological changes are pronounced among mountain people who have lived in cold, high altitudes for generations. Compared to lowlanders, their bodies are short, squat, stocky, and barrel-chested, and their hands and feet are stubby. Their hearts are bigger and slower beating and their capillaries are wider. Their bodies contain 20 percent more red blood cells than lowlanders' do and these red blood cells are larger. The alveoli in their lungs are more open for oxygen absorption. Many develop a fatty epithelial pouch around the eyes to counteract cataract and snow blindness.[4] Populations at high altitude often use narcotics, such as coca or hashish, to help manage the pain and stress of high altitude.

High altitudes are characterized by extreme cold, strong winds, thin air, intense solar and ultraviolet radiation, deep snow, raging thunderstorms and blizzards, and heavy fog and rapidly changing weather, including severe storms which can cut off outside contact for a week or longer. Avalanches and rockslides are not uncommon. Although jungle or forest may hug the mountain base, trees do not grow past 10,000 to 11,500 feet [3,000 to 3,500 meters], depending on the latitude.

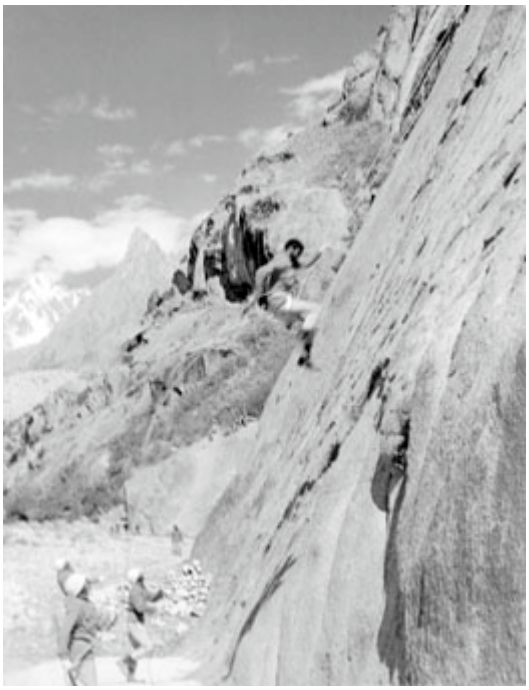
Physical conditions at high altitude are often more dangerous than enemy fire. Superficial bullet and shrapnel wounds can quickly turn fatal at altitude. Movement in the high mountains often results in broken bones, severe lacerations, contusions, and internal injuries caused by falls and falling rock. Frostbite and hypothermia are a constant danger. Acute mountain sickness, high altitude pulmonary edema, and cerebral edema are frequently fatal consequences of working at high altitude. Mental and physical abilities decrease at high altitude and high altitude also induces personality disorders. Sudden weight loss is often a problem. The rarefied atmosphere

permits increased ultraviolet ray exposure, which creates problems with sunburn and snow blindness. High altitude shelter heating is often by unvented kerosene stoves, which means that personnel breathe air, which is thick with soot.[5]

Equipment will not function, or functions marginally, at high altitudes. On the average, vehicles lose 20 to 25 percent of their rated carrying capability and use up to 75 percent more fuel.[6] Military generators and vehicles are often diesel-powered, but standard diesel engines lose efficiency at 10,000 feet [3050 meters] and eventually stop functioning altogether because of insufficient oxygen. Artillery firing tables are wildly inaccurate as the changed environment allows rounds to fly much farther. Lubricants freeze; altitude and weather limit helicopters; and additional animal or gasoline-fueled overland transport adds to the physical demands and logistic requirements of this environment.

Getting There is Half the Fun

At high altitude, personnel have difficulty breathing because of decreased atmospheric pressure and subsequent rarified oxygen. Soldiers selected for high-altitude duty should be screened for their ability to function in this environment. Soldiers should be in excellent physical condition and have sound hearts and lungs. Short, wiry soldiers are preferred to tall, muscular soldiers. Selected soldiers should have above-average intelligence to allow them to more-readily adapt to the trying terrain. Personnel who have had radial keratotomy corrective eye surgery should not go to high altitudes because their vision may permanently cloud.



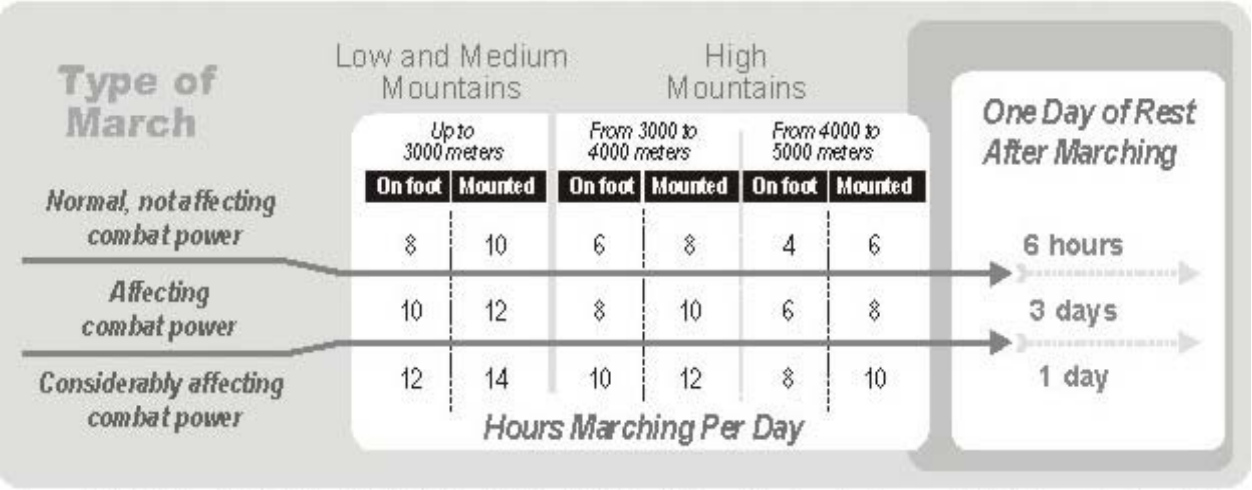
Pakistani soldiers train in rappelling techniques at the Mountain School.

All personnel should undergo an acclimatization program to accustom them to their new environment and to improve their respiratory and cardiovascular systems. A physically fit soldier can adapt to the cold in about 3 weeks.[7] The body normally adapts to a higher altitude in about 2 week's time. During the acclimatization phase, the body accumulates additional red blood cells which help transport needed oxygen.[8] The Pakistani army acclimates their personnel over 7 weeks. They begin with a 3-week stay at 10,000 feet [3050 meters] where personnel acclimate to the cold while they undergo daily physical conditioning and learn mountaineering, rock climbing,

rappelling, and mountain survival. During the final 4 weeks, soldiers learn advanced mountaineering techniques, trek to 14,000 feet [4270 meters] and return; trek to 17,000 feet [5185 meters] and return; and finally trek to 19,135 feet [5836 meters].[9]

Despite all training and efforts, acclimatization is not possible at heights over 18,000 feet [5418 meters], so exposure at these heights must be limited and closely supervised. Personnel at high altitudes need to be rotated out every 10 to 14 days. The Indian army acclimates its personnel over a 14-day schedule with increases in altitude at 6 days, 4 days and then another 4 days. The Indian army characteristically conducts its acclimatization by having the battalion hike from its road head to the staging area. All experienced armies agree that high-altitude acclimatization cannot be achieved in less than 10 days. An acclimated soldier is still not an experienced mountaineer. Experience counts and is not gained in 2 months of training. Some armies, such as Italy's, believe that 10 years is not too long to produce a truly capable, experienced mountain warrior.

Figure 1: **Average movement rates at altitude for trained, acclimated personnel and animals**



Source: ROP-00-06, *Conducción de la Brigada de Montaña* (Mountain Brigade Field Manual) (Buenos Aires, Argentina: Government Printing Office, 1998), Annex 15, 279.

Nothing is fast in high-altitude combat. Logistics support is key and the location of logistics dumps determines operational axes. The distance between the road head-the furthest point that supplies can be moved by truck-and the forward posts determines how many troops can actually man the forward posts. Forward posts can be a 3 to 14 day foot march from the road head. The farther the forward post is from the road head, the greater the number of troops necessary to support it. Base camps are usually built around road heads. Supplies and men travel forward from the base camps through intermittent staging posts to the forward posts. Helicopters, porters, or mules are used to move supplies from the road head. Despite attempted technology fixes, the mule is the most efficient way of moving material in the high mountains. Mules require care, attention, and training. Armies with experience in high mountains maintain trained mules and muleteers. Even mules cannot reach the higher elevations, and porters must haul the supplies forward.

Movement is calculated in time rather than distance at high altitude. Figure 1 shows average movement rates of trained, acclimated personnel and pack animals in the mountains.

The terrain slope as well as physical conditioning and altitude acclimatization of the troops determines the distance that can be covered. Figure 2 gives a rough average for determining distances over time using conditioned, acclimated troops.

Moving in the high mountains can be perilous. Weather can rapidly change and columns can become lost in blizzards or fog. Trail markers can quickly disappear under falling snow. Snow bridges can collapse and swallow climbers into deep crevasses. Entire patrols have disappeared without a trace while moving to the Siachen Glacier.

Figure 2: **March distances over time in the mountains**

Slope Grade		Low and Medium Mountains		High Mountains		Observations
		On foot	Mounted	On foot	Mounted	
0% to 4%	Descent	4.0 Km/hr	8.0 Km/hr	4.0 Km/hr	7.0 Km/hr	Mounted troops travel walk speed
	Ascent	4.0 Km/hr	8.0 Km/hr	3.7 Km/hr	7.0 Km/hr	
5% to 9%	Descent	4.0 Km/hr	8.0 Km/hr	4.0 Km/hr	7.0 Km/hr	
	Ascent	3.7 Km/hr	7.3 Km/hr	3.0 Km/hr	6.5 Km/hr	

Source: *Conducción de la Brigada de Montaña*, Annex 13, 271. Conditions for the march: day, good weather conditions, on a trail or road in good condition, firm ground, troops and packed animals trained and acclimatized.

Line-of-sight communications is excellent in the mountains but difficult to achieve because of high peaks. Therefore, communications sites are carefully selected and often become key terrain. Very-high frequency radios with automatic frequency hopping, encryption, and burst transmission capabilities work best. Normal batteries quickly lose power in the cold, so lithium batteries should be the normal issue.[10] Frequently, mountain tops become part of the national communications infrastructure because they are crowded with military, national, and commercial radio and television sites and telephone relay towers. These vital areas need to be protected, and military platoons often garrison such communications sites against guerrilla attacks.

Combat at Altitude

There are two primary scenarios for combat at altitude. First, two states dispute the boundary between their countries and maintain forces supporting a rough line of demarcation along the disputed zone (Kashmir and Siachen Glacier between India and Pakistan, and the Kameng Frontier Division between India and China). In this scenario, opposing forces hold linear defenses along the line of demarcation, regardless of altitude, and conduct a fairly positional fight.

Second, a light infantry force of guerrillas, smugglers, bandits, or forces from a neighboring state transverses the mountainous region to establish base camps in the mountains from which they patrol, launch raids, or maintain smuggling routes. This has been the pattern for a number of high-altitude disputes such as the Mau Mau uprising, Soviet-Afghan war, Sendero Luminoso in Peru, Russo-Chechen wars, and Colombian efforts against the FARC and ELN. In this scenario, the fighting does not automatically gravitate to a border zone, but usually stays below the tree line.

At altitude, the first enemy is the environment. The second enemy is the human foe. At altitude, high ground is not always key terrain. Frequently, key terrain is related to mobility-passes, main supply routes, road heads, and intermittent staging posts. Light infantry and artillery are the primary combat forces.

Offensive actions in the mountains include infiltration, ambush, raids, patrolling, shelling attacks, limited air assault, and limited offensives. Pursuit is seldom possible. Envelopment is the most common maneuver and the frontal attack is the least desired option. Defensive actions include counter-infiltration, ambush, patrolling, and positional defense. Relief in place is routine small-unit action.

Offensive actions should focus on interdicting logistics by blocking passes, denying use of supply and transit routes, capturing base camps and intermittent staging posts, and destroying transport.[11] Force oriented offensive actions, such as interdicting patrols or raiding artillery positions, make great headlines and can boost morale, but they seldom have the long-term effect as actions against logistics. Offensive actions are small-unit actions, since only small units can be supported at altitude and frequently the terrain is so restricted that too many soldiers would hamper the effort. Movement is by small groups moving at a walk to avoid sweating because sweat freezes quickly leading to frostbite. Objectives are close at hand so the attackers will not be exhausted before they arrive and will not be caught in the open by rapidly changing weather. Assembly areas may be nonexistent and the attackers will have to move directly from forward positions. The attack may have to go in waves if suppressive fire is inadequate or the enemy is conducting a reverse-slope defense. The offensive plan must be clear, as most mountain maps are problematic. Maneuver is dictated by terrain and the reserve is committed early since movement is slow and mutual support is very difficult to achieve. Maneuver is slow and limited in distance. A maneuver force can range from one or two men to a full battalion if weather and the enemy situation permits.

Defending at altitude is difficult because of limited troops and material. When defending along a border, a battalion holds an extended frontage (7,000 to 8,000 yards) while a company holds 1,500 yards, so there is little depth, or large gaps, in the defense.[12] Further, the complete battalion is seldom on line simultaneously. Often, a platoon holds a company position since the rest of the company is being held in reserve at lower elevations where the deterioration of the body is not as rapid. The platoon is rotated every 10 to 14 days. The entire company must still be rotated to lower elevations to recoup every 3 to 4 months. This means that the long, linear defense is actually a string of strong points built around a machine gun. Reverse slope defense, with forward slope observation posts is preferred, since the defensive positions often lack overhead cover and are susceptible to artillery airburst.

Argentinean mountain troops carefully cross the Castano Overo Glacier on Mount Tronador (11,800 feet). They are roped together, moving cautiously in single file, in case one of them falls into a snow-covered crevasse. At such altitudes, artillery remains the around-the-clock fire support system because of aircraft limitations.

A great deal of daily effort is required to keep snow from completely filling the defensive positions and hiding the trails. Permanent shelter, such as portable fiberglass huts, are essential at the defensive positions.[13] Fortifying defensive positions is difficult since this usually requires the delivery of heavy materials such as cement, sand, water, and roofing timbers. Sensors are a welcome addition to the defense in those areas where they will not be rapidly covered by snow. Defensive positions should be designed and stocked to hold out independently for days since relief in the mountains is problematic due to weather. Conversely, when the enemy is a guerrilla force, the defensive position is a perimeter defense from which patrols, ambushes, and raids are launched.

Mountain patrolling is a common feature of the offense and defense. Small patrols are at risk, so platoon-sized patrols are common. Single patrols are useless, so multiple patrols are normal. Local guides or scouts are an essential part of each patrol. Detailed planning is an essential part of the patrol plan and includes a reaction force or reserve. The meeting battle is normal combat at altitude resulting from probing actions by opposing patrols.

Raids are a common offensive and defensive tactic. They are designed to seize a point, exploit success, and then withdraw. Raids are a temporary measure to capture personnel and equipment, destroy installations, bait traps to draw enemy reaction, and attack morale. Since there is no intention of holding the objective for a length of time, the logistics burden is less onerous than a deliberate attack. Successful mountain raids normally incorporate an assault force, a fire support group, and a security element.[14]

Fire Support at Altitude

Mountains restrict effective bombing and strafing by jet aircraft. It is difficult for them to pick out targets that are camouflaged or concealed by natural cover. Weather, deep shadows, and the environment also restrict pilots' vision. There are few approach routes and most of those are along valleys, which are covered by air defense and infantry forces using massed fire. Climate and terrain restrict jet aircraft from diving freely or flying low enough to engage targets

effectively. Still, camouflage discipline, controlled movement, and layered air defense are essential to prevent savaging by high-performance aircraft.[15] Helicopter gunships are more of a danger to ground forces, but eventually altitude limits their effectiveness. Lightweight helicopters can serve effectively as artillery spotters. All aviation is subject to the vagaries of weather at high elevation, which is powerful, constantly changing, and often shuts down flying. Dense fog, high winds, and blizzards are common and whiteouts are a constant threat to pilots.

Artillery remains the round-the-clock fire support system. However, artillery is often constrained during high-altitude combat. Sharp bends, high gradients, and the general condition of mountain roads restrict the movement of artillery, towed guns in particular. There are a limited number of gun positions, so artillery batteries are seldom deployed intact. One- and two-gun or rocket launcher positions are common. Consequently, the number of alternate firing positions is also restricted and these positions tend to become permanent. Guns should be moved at night for protection against enemy aircraft and artillery. However, night movement of guns in mountainous terrain is risky and accident-prone. Artillery positions should be constructed so that gun crews can defend them against ground attack. Firing positions should be on reverse slopes and as close to the crest as possible-considering crest clearance and flash-cover. Individual guns should be sited in terrain folds and other places where they are naturally concealed.[16] Artillery plays a major role in logistics interdiction, counterbattery and shelling front-line units. Artillery can create havoc with a forward defense by targeting living accommodations and using airbursts against troops in the open.[17] Mortars are frequently more effective than guns or howitzers. They are easier to shift around, can better engage reverse slopes and can be moved closer to the forward posts.

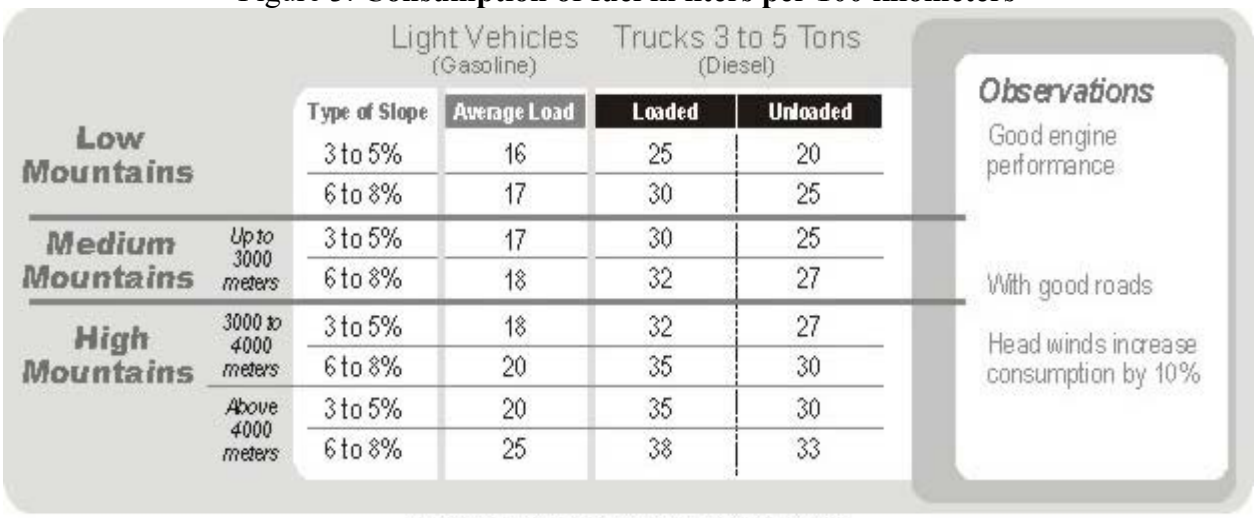
Transport frequently determines the location of artillery and mortars and the supporting range of artillery. Artillery cannot be readily moved where there are not roads. Artillery firing points are usually located where ammunition can be delivered-in valleys, villages, and near road heads.

Logistics Support

High-altitude logistics are key since the terrain and unique environment hamper delivery to the forward troops. Logistics always drives the battle, but in high-altitude combat, this is especially so. Without good highways or railroads, dump sites cannot be readily moved, it takes an inordinate amount of time to shift troops from one sector to another, and logistics demands are considerably higher than in other types of light infantry combat. Trucks, helicopters, mechanical mules, and snowmobiles are key to mountain logistics, but above 13,000 feet, the logistics effort shifts to the backs of mules and porters. Naturally, this is the point where the logistics delivery system snarls since porters and mules have distinct limitations and there are never enough of them.

Trucks are important to logistics support and gasoline-powered trucks are clearly preferred over diesel. As the truck ascends the mountain, the amount of oxygen available is reduced and the engine efficiency drops off. Cross-country and climbing capability decline as fuel usage soars. Diesel engines may need to be fitted with turbochargers and gasoline engines may need their carburetors adjusted. Figure 3 shows the average increase in fuel consumption at altitude.

Figure 3: **Consumption of fuel in liters per 100 kilometers**



		Type of Slope	Light Vehicles (Gasoline) Average Load	Trucks 3 to 5 Tons (Diesel) Loaded	Trucks 3 to 5 Tons (Diesel) Unloaded
Low Mountains		3 to 5%	16	25	20
		6 to 8%	17	30	25
Medium Mountains	Up to 3000 meters	3 to 5%	17	30	25
		6 to 8%	18	32	27
High Mountains	3000 to 4000 meters	3 to 5%	18	32	27
		6 to 8%	20	35	30
	Above 4000 meters	3 to 5%	20	35	30
		6 to 8%	25	38	33

Observations

Good engine performance

With good roads

Head winds increase consumption by 10%

Source: *Conducción de la Brigada de Montaña*, Annex 16, 281.

Helicopter-based logistics are the preferred mode in mountain warfare, but the mountains are not the optimum helicopter environment. Air density decreases with altitude and mountain winds and updrafts are unpredictable and dangerous. Proper landing zones are difficult to find and, if close to the enemy, probably under enemy mortar and small-arms coverage. Helicopters must follow the terrain features of the mountains adding predictability to their approaches and increasing the risk to the crew. Fog, sudden storms, icing, and variable winds can quickly shut down helicopter support. Mountain terrain interferes with air-to-ground communications and with air-to-air communications. Planning for helicopter support in the mountains requires detailed planning, first-rate liaison, and a habitual association between the helicopter and ground unit encompassing training and social events. Flying in the mountains is so different that the armies of India, Pakistan, Columbia, Argentina, and Switzerland have special mountain flight courses for their helicopter crews.

A Step Back in Time

High mountains are countertechnology. Mules are a good option for high-altitude logistics. They can use very narrow trails, can carry more than a human porter, and tire less over long distance. American mules can carry up to 20 percent of their body weight (150-300 pounds) for 15 to 20 miles per day in mountains.[18] Smaller mules in other locales will carry less. The maximum carrying weight for an Argentine mule is between 200 and 250 pounds. However, this is for low- and medium-altitude mountains. At high altitude, the maximum carrying weight drops below 200 pounds. Organized mule cargo units, rather than ad hoc teams led by local teamsters, are the preferred option, but local mules are always preferred over deployed mules.

U.S. Army mules support the 5th Army advance in Italy during World War II while a cargo truck lies helplessly on its back.

Mules were part of the U.S. Army during World War II in Burma and Italy and were a critical element of the Mujahideen supply effort in the Soviet-Afghan war. They remain part of the force structure of many contemporary forces with high-altitude mountain troops. Other armies contract mule transport through local teamsters. Yet mules have their limitations. If the snow is too deep, they simply refuse to move.

American mules require 10 pounds of grain and 14 pounds of hay per day, which also becomes part of the logistics load.[19] The smaller mules of Argentina require eight pounds of grain and eight pounds of hay per day. Mules consume 25 to 30 liters of water a day and up to 50 liters in desert country. They also require a daily ounce of salt. Like humans, mules require time to acclimate to altitude. Muleteers and mules require about a month's training to get them ready to work above 3,000 meters. Like humans, mules tire easily above 4,000 meters and need to be rested frequently. Mules also have to be trained not to fear the noise of firearms and explosives so that they do not run off during a march.[20]

Mules are subject to colic, heat exhaustion, injuries, and wounds. Most injuries and wounds result from poorly adjusted saddles, pack frames and harnesses. Stones, rocks, and debris on the trail can also wound a mule's hoof. Local mules are more immune to disease at altitude than humans and all mules have a keen sense of self-preservation that keeps them alive in mountain storms.[21] Mules require a great deal of daily care and training. Muleteers, farriers, blacksmiths, and large animal veterinarians, who have been absent from many armies for decades, are essential for mule-borne logistics. Mules need new shoes every 30 days and there are special mule shoes for snow and ice. Figure 4 shows the supply and transport estimate for a 171-man light infantry company planning a mountain march, attack and defense lasting for a total of 6 days. Since much of the material will be kept in dumps and moved in stages, the commander has managed to keep his transport requirements in hand.

Figure 4: **Weight and transport requirements for a 171-man light infantry company**

Rations	1,620 kilos	Assault & field rations
Ammunition	1,021 kilos	One basic load-circumstances may require carrying more
Water (drinking and cooking)	2,262 kilos	2,565 liters
Total weight (for company)	4,903 kilos	Not counting food, water, ammo, and packs carried by soldiers
Mules (to haul weight)	61 mules	Small mules haul 80 kilos; Big mules up to 150 kilos
Mules (to haul crew-served weapons)	20 mules	Machine guns and mortars
Mules (to haul fodder, grain, salt and water for mules)	151 mules	5,620 kilos of fodder, 4,060 kilos of grain, 348 kilos of salt, and 18,416 kilos of water

Source: Major Valero, Training exercise material, Army of Argentina

Porters should be hired from the local populace since they are acclimated to the elevation and are accustomed to moving around the mountains safely. Locals used to carrying loads have developed endurance and are accustomed to breathing thin air. Although a porter cannot carry as much as a mule, they can move in places where mules cannot. However, porters will probably be reluctant to work too far away from their homes and villages. There is always a security consideration when using local porters. Figure 5 shows porter-carrying capabilities.

Figure 5: **Cargo capabilities of porters in mountainous terrain**

Personnel		Low and Medium Mountains	High Mountains	
		Up to 3000 meters	**3000 to 4000 meters**	**Above 4000 meters**
Man on foot	*Porter*	20 Kg	20 Kg	15 Kg or less
	Combat Soldier	15 Kg	10 to 12 Kg	8 to 12 Kg or less
Man with skis	*Porter*	20 Kg	12 to 15 Kg	12 Kg or less
	Combat Soldier	12 Kg	12 Kg	10 Kg or less

Source: *Conducción de la Brigada de Montaña*, Annex 17, page 283.

During the Peru-Ecuador border conflict for the Condor Cordillera in 1994, the Peruvian army relied on porters exclusively for resupply. Although the fight was in medium-altitude mountains, not over 2500 meters, the forward logistics support was restricted to porters because the steep mountains were covered with thick jungle, had few trails, and the Peruvian army lacked trained mules and muleteers. The Peruvian army moved its supplies from one small village to the next, using local villagers as porters to carry the supplies eventually to the fighting up on the Condor Cordillera.

Front-line combatants need daily supplies of ammunition, food, water, and heat for survival. Figure 6 shows daily consumption rates of water and wood fuel.

Figure 6: **Consumption of water and wood**

	Water				Wood		
	Man		Animal		Cooking	Heating	
	Drinking	*Cooking*	*Summer*	*Winter*	*Uncovered*	*Tent/Shelter*	*Open*
Low and Medium Mountains	1.5 to 2 Liters	5 Liters	15 Liters	10 Liters	1 kg per man	1 kg per man	1 kg per man
High Mountains	2 to 2.5 Liters	8 Liters	15 Liters	10 Liters	1 kg per man	Every 6 hours	Every 2 hours for fire

Source: Conducción de la Brigada de Montaña, Annex 18.

In the mountains, a battalion task force tries to carry and stockpile enough supplies to operate for 1 to 2 weeks. This requires expending time and energy to establish supply dumps along the main supply route. Naturally, the shorter the supply route, the easier it is to protect. If roads, tracks, and trails are under enemy control, the unit might be restricted to helicopter supply and its inherent problems in the mountains. Logistics support at higher altitudes during winter may become impossible causing opposing forces to withdraw.

Medical evacuation at altitude is frequently difficult. Weather or weight limitations may prevent a helicopter from flying to a patient. Often, patients must be carried on stretchers to lower elevations where the helicopters can reach. Soviet experience in the mountains of Afghanistan proved that 13 to 15 men might be involved in carrying one patient. Exertion at altitude is difficult and the stretcher party has to provide its own security as well.[22] Patients cannot be effectively treated at altitude, but have to be evacuated to lower altitudes to survive.[23]

The Eternal Mountains

Mountain terrain is difficult, movement is slow and the hazards to health and physical well being are significant and constant. Combat at high altitude is a historical constant and a contemporary fact. It cannot always be avoided. Training for mountain combat is not simply light infantry training. Special training and acclimatization is necessary.

Leadership is particularly important in mountain combat. The harsh living conditions, physical deterioration, and psychological depression inherent in mountain combat require skilled leaders. Armies with regimental systems and years-long association find it easier to cope with the leadership challenges of mountain combat. Combat is primarily small unit, placing a great deal of responsibility on platoon and squad leaders.

Fire support is difficult. Artillery firing tables are inaccurate and artillery is hard to move on mountain roads. Transporting guns by helicopter is recommended where possible. Moving guns and ammunition takes an unusual amount of time. Helicopter gunships provide excellent support at lower altitudes. Mortars are excellent for hitting reverse slope positions, but have limited range.

Logistics are a primary concern in mountain combat with transport to altitude requiring special effort. Sustained combat requires an inordinate logistics effort. Small-unit actions, where units do not remain for extended periods of time, do not impose the same logistics burden.

Although the U.S. Army has not fought at truly high altitude, this may not always be the case. High mountains occupy much of the world's surface and they are not immune to the world's conflicts. Other nations have successfully fought at altitudes above 10,000 feet. Should the U.S. Army find itself committed at these altitudes, the experiences of other nations are invaluable. Preparation for such an eventuality should begin well before crisis dictates deployment.

1.Carl von Clausewitz, *On War*, ed. and trans. by Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1989), 432. The authors thank mountain warriors Lieutenant Colonel (LTC) German Giraldo, Army of Colombia; LTC Foto Duro, Albanian Army; Major (MAJ) Alejandro Valero, Army of Argentina, MAJ Akbar Khan, Army of Pakistan; and LTC Tejbir Singh, Army of India, for their input, suggestions, critique, and guidance. The authors retain responsibility for the accuracy and ideas in the article.

2.*The Houghton-Mifflin Dictionary of Geography: Places and Peoples of the World* (Boston, MA: Houghton-Mifflin Company, 1997), 48, 164, 165, and 450.

3.Tim J. Setnicka, *Wilderness Search and Rescue* (Boston, MA: Appalachian Mountain Club, 1980), 620.

4.Syed Ishfaq Ali, *Fangs of Ice: The Story of Siachen* (Rawalpindi, Pakistan: American Commercial PVT Ltd., 1991), 15-16 and 110-11.

5.Lester W. Grau and William A. Jorgensen, "Medical Implications of High-Altitude Combat," *U.S. Army Medical Department Journal*, to be published April 2002.

6.Aleksey Svetlanov, "Osobennosti razvedki v gorakh" (Peculiarities of Mountain Reconnaissance), *Voyennye znaniya* (*Military Banneri*) (June 2000), 13.

7.Salman Beg Punjab, "Operations in Glaciated Areas," *Pakistan Army Journal* (Spring 1994), 5.

8.Setnicka, 623.

9.Ali, 16-17; Punjab, 5-6.

10.Punjab, 7.

11.Ibid., 8-9.

12.Iftikhar ur Rahman, "Defensive Battle in Mountains," *Pakistan Army Journal* (September 1984), 31.

13.Punjab, 4.

14.Ali Ahmad Jalali and Lester W. Grau, *The Other Side of the Mountain: Mujahideen Tactics in the Soviet-Afghan War* (Quantico, VA: U.S. Marine Corps Study: DM: 980701, 1998), 69-103 and 211-25.

15.Sikandar Hameed, "Local Defence of Gun Area in Mountainous Terrain," *Pakistan Army Journal* (March 1983), 35-41.

16.Ibid.

17.Punjab, 10.

18.U.S. Army Field Manual 31-27, *Pack Animals in Support of Army Special Operations Forces* (Washington, DC: U.S. Government Printing Office, February 2000), 1-2.

19.Ibid., 2-14.

20.*Reglamento Funcional Público* (Public Functional Regulation) 24-02, *Reglamento Ganado de Servicio* (*Service Livestock Regulation*) (Buenos Aires, Argentina, 1994), 36.

21.Ibid, Annex 18.

22. 22.Boris Gromov, *Ogranichennyy kontingent* (*Limited Contingent*) (Moscow: Progress Publishers, 1994), 186.

23.Grau and Jorgensen.

Argentine Army
Pakistan Army Journal
US Army