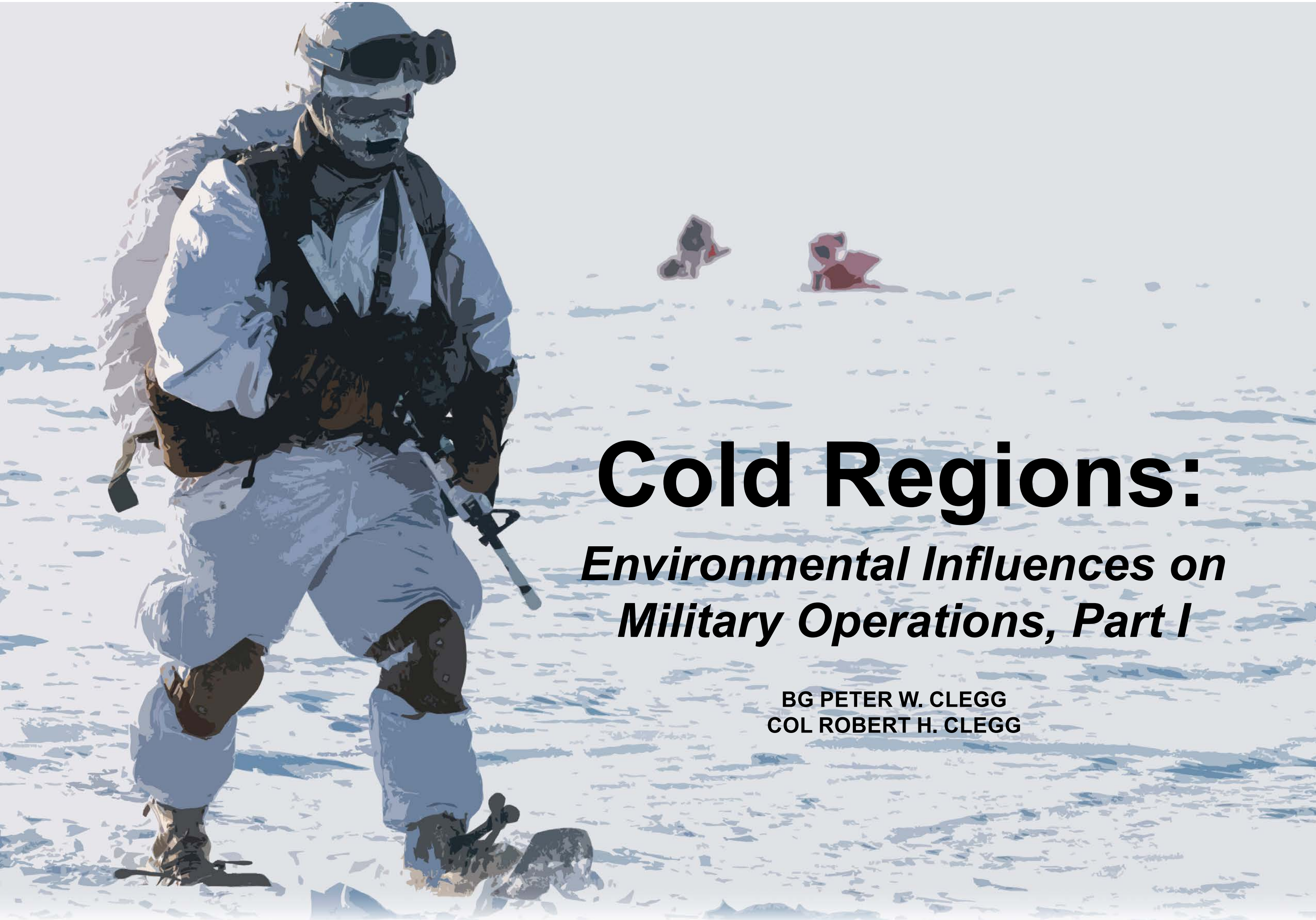

Cold Regions:

Environmental Influences on Military Operations, Part I

BG PETER W. CLEGG
COL ROBERT H. CLEGG

Editor's Note: *This article first appeared in our July-August 1992 issue.*

Cold regions comprise some 45 percent of the earth's land surface. Population is sparse in most of the extreme cold regions. Some major world population centers do exist in the less cold areas, however, and these centers have considerable strategic significance for the United States for both economic and geo-political reasons.

Although fewer conflicts have occurred in cold regions than elsewhere in the world, those few conflicts have been devastating in terms of loss of life and property damage. Napoleon's "Grande Armee," for example, was reduced by 90 percent (more than 500,000 men) in the Russian heartland in 1812, primarily by the effects of weather. The Russo-Japanese War, World War I, the Russian Civil War, World War II, and the Korean War accounted for millions of fatalities. The Japanese takeover of Manchuria in 1937 also produced staggering casualties, and the Russo-Finnish War in 1939-1940 alone added 850,000 to the casualty toll.

The U.S. Army, from its very beginning, has experienced the rigors of combat in cold regions. Cold weather affected combat in the Revolutionary War and the War of 1812 on the Canadian frontier. The Army has engaged in cold region military operations in Iceland and northern Russia in World War I, in the Aleutian Islands in World War II, and in Korea during the Korean War.

Today, the U.S. Army is fully trained to operate in cold regions. Such units as those assigned to U.S. Army Alaska, the 10th Mountain Division in upstate New York, and others regularly train in freezing temperatures and snow-covered terrain.

The Army also has two cold region training centers that produce hundreds of trained arctic warriors each year: The Northern Warfare Training Center at Fort Greely, AK, and the Mountain Warfare School, run by the Vermont Army National Guard.

The Army must continue to train for operations in cold environments because portions of our own country and other areas of interest lie within cold regions. Leaders must come to appreciate the effects of cold on soldiers, equipment, facilities, support, and combat operations. Before focusing on these effects in Part 2 of this series, it may be useful to look at some of the basics of weather and terrain.

Climatic and Meteorological Conditions

Cold regions are those that are north of 40 degrees latitude in North America and 50 degrees latitude in Eurasia, and in Antarctica, the only cold region in the southern hemisphere.

Polar climates consist of the ice cap found in Antarctica and the interior of Greenland, and the tundra found in the coastal regions of Antarctica, Greenland, northern Iceland, and coastal land areas of the Arctic Ocean in North America and Asia.

These regions occur in response to the specific climatic controls — latitude, land-water contrast, mountain barriers, ocean currents, and altitude. These controls influence temperature and moisture and therefore atmospheric pressure and wind.

The primary control responsible for cold climates is latitude and its influence on incoming solar radiation, which determines temperature. Temperature is a product of solar intensity and duration. For regions north of latitude 23½ degrees N or south of latitude 23½ degrees S, direct sun rays are not possible because of the earth's curvature and inclination; the rays are therefore less intense. The dark winter period, combined with low solar intensity, creates a thermal deficit that the summer, when solar duration is longer and intensity a bit stronger, cannot balance.

Another factor that is responsible for cold climates is land-water contrast. Because land heats and cools faster than water, coastal areas are more moderate than continental interiors. The centers of Asia (Siberia) and North America (north of the Great Lakes area) experience bitterly cold conditions. Land-water contrast is made worse by yet another climatic control — the presence or absence of mountain barriers. For example, the northern areas of Siberia are flat, and cold air can penetrate south because nothing blocks its flow; in southern Siberia, mountains block warm air from the south and keep it from moderating temperatures to the north.

Ocean currents also contribute to the creation of cold regions, and Iceland is the prime example. The northern half of Iceland has a tundra climate, while the southern half has a much warmer "marine west coast" climate. The cold Greenland current flows south from the north pole along the coast of Greenland, bringing cold conditions to the coastal areas of northern Iceland. The warm Gulf Stream current coming up the east coast of the United States and then across the North Atlantic moderates the climate in the southern half of Iceland. (Actually, the mountain ranges channel some of the warm air north to Akureyri, Iceland's second largest town, located in the center of the north coast. Its climate is milder than that anywhere else in northern Iceland.)

Temperature, the dominant climatic element, controls moisture and pressure, which in turn determine wind. Temperatures in cold regions can get so low that metals become brittle, liquids become solid, and humans die. Temperatures as low as -100 degrees Fahrenheit have been recorded in the middle of Siberia.

Snow cover reduces temperature in winter. A blanket of snow can insulate and retain energy the ground has absorbed, but it can also reflect solar radiation so that the ground absorbs less than 10 percent of the available winter energy.

Temperature is also responsible for atmospheric moisture, which leads to precipitation. Higher temperatures allow for evaporation and for large quantities of moisture in the air, while lower temperatures inhibit both evaporation and the air's capacity to hold moisture. Since cold air cannot hold much moisture, even a small amount results in a high percentage; when relative humidity reaches 100 percent, condensation results in dew, fog, and clouds. With further cooling, precipitation occurs in the form of rain, sleet, hail, or snow.

In cold regions, there is little evaporation. Some precipitation does occur, however, along coastal areas and over the Arctic Ocean, and this accounts for the frequent fog and snow in these areas. (Surprisingly, cold regions get nearly the same amounts of precipitation as hot desert areas, especially polar climates where the average precipitation is less than ten inches a year.)

Terrain

Three dominant types of terrain characterize cold regions — glaciated terrain; wide, flat, marshy plains; and mountains, which can be either spines of Alpine mountain ridges separated by plains, or coastal highlands (characteristically rocky with fiords and cliffs, as opposed to sandy beaches). Vegetation, drainage, and man-made features differ in each of these categories.

Soldiers with the 1st Squadron, 40th Cavalry Regiment move toward an extraction point after an airborne operation in Deadhorse, AK, on 22 February 2017. The unit's arctic capabilities were tested as temperatures with wind chill reached as low as -63 degrees Fahrenheit.

Photo by SSG Daniel Love

Glaciated terrain is terrain that was scoured at some time in the past by sheets of ice as much as a mile thick in some cases. With warmer conditions these glaciers melted and receded, leaving behind a series of unique landforms of glacial scouring and deposition. The scoured areas allowed for numerous lakes arranged in the direction of the glaciers' movement. The finger lakes of New York, the Great Lakes, and the many lakes of Minnesota are examples.

Glacial deposits include large linear mounds called moraines, up to 1,000 feet high. Long Island, NY, is a terminal moraine. Serpentine ridges (or *eskers*) and large scattered hills (*kames* and *drumlins*) litter the glacial plains. Many of the lakes have dried into marshes and now cover vast areas. Glaciated terrain is found in New York and New England, across Canada, the upper U.S. Midwest, eastern European Russia, Northern Europe, and Scandinavia.

Vast plains also characterize the topography of cold regions. Most of Canada surrounding the Hudson Bay, the U.S. Midwest directly below the Great Lakes, and the West Siberian Plain (east of the Ural Mountains) fit this description. The extreme flatness allows for marshy conditions during summer as rivers drain northward, fed by melting snow and ice in the mountains on the periphery of these plains.

Mountainous terrain includes high alpine mountain chains a thousand miles or more long with flat plains between them. In Alaska, the Brooks and Alaska chains extend east to west, bend southward in Canada, and become the Rocky Mountain and the coastal Cascade ranges of the continental United States. In Central Siberia and the Russian Far East, numerous faulted and folded mountain chains characterize the topography. Within these mountains are glaciers that carve U-shaped valleys. Lesser mountains such as the Appalachians and the southern Urals, which are more temperate areas, do not have these alpine glaciers, and their valleys tend to be V-shaped from stream cuts.

The vegetation of cold regions is varied and abundant, except in the polar regions. Off the ice cap in the tundra are short tufts of moss, muskeg, and lichens; to the south (but still in the tundra), shrubs and bushes predominate. In the warmer areas of the subarctic, the tree line begins with sparse, thin-diameter, needle-leaf trees. Moving south, the trees become denser, more varied in species, and thicker in diameter.

Thick forests of larch, tamarack, fir, and pine trees form the *taiga* or *boreal* forest (a moist subarctic coniferous forest that begins where the tundra ends). Conditions in the southern areas of the tiaga allow for deciduous trees (mostly birch, alder, aspen, willows, and cottonwood), and farther south in warmer humid microthermal climates are mixed forests of evergreen and deciduous growth.

Few man-made features are found in the inhospitable climate of the really cold regions. More than 90 percent of the population is concentrated in urban areas, primarily because of the need for fuel, food, and shelter. Still, some of the world's largest networks of cities are found in the humid continental warm-summer sub-climate, and man-made features complicate the terrain.

Military Aspects of Terrain

In cold regions, the terrain and weather vary considerably. The constraints that polar climates impose on combat operations are markedly different from those of the more moderate humid microthermal regions.

In the far north, the lack of vegetation allows for almost unrestricted views, and relief is the restrictive element. The wide, flat plains provide ideal fields of fire and observation. The problem in these areas is finding elevations from which to observe. Thick fog also reduces visibility over the coastal tundra, especially in the spring and fall.

Farther from the poles, observation and fields of fire are inhibited only by terrain and atmospheric conditions, and vegetation becomes increasingly significant. Dense shrubs restrict ground observation. Dead space created by stream cuts and glaciated hummocky mounds must be covered by indirect fire. Once across the tree line and into the forests, observation and fields of fire are restricted, and trees may have to be removed. The lack of underbrush in the deep conifer forests helps ground observation. Cleared farmlands in the southern limits of the cold regions provide excellent observation and fields of fire. Since these areas are also urbanized, however, this advantage is often lost.

The clear, dry, stable air of winter allows for unrestricted views, but fog along coastal areas can last for several days and reduce observation to only a few feet. The numerous lakes in glaciated terrain and the marshes of the wide flat plains allow for fog in the spring and fall. At extremely low temperatures, ice fog that forms due to weapon firing and vehicle exhaust limits observation from the ground to altitudes of about 900 meters. Frontal storms throughout the year and blizzards in the more southern cold regions reduce observation temporarily.

Illumination is determined by the moon phase and the length of the day. In extreme northern areas, summer daylight is almost total, as in winter night. But a full moon reflecting the sun's light on blankets of snow provides good nighttime illumination. Clear, dry, atmospheric conditions help this regard.

Such conditions also improve the efficiency of sensors. Light-intensifying devices work well because of clear stable air, and thermal sensors are especially effective when the background is snow. One problem, though, is that the difference between the temperature of a target and the cold topography can make returns overpowering and identification tricky.

Glare is another problem in cold regions. Again, clear dry air and snow help reflect the sunlight, and glare can cause loss of vision. (Sunglasses help.) When snow blows all around (from helicopters, for example), whiteout becomes a problem. It distorts depth perception and sense of direction and results in deadly accidents for aviators.

In the isolation of the far north, any man-made feature is important and may even be key terrain. Settlements where a logistics base may be established, road junctions, river crossing

Photo by SSG Nathan Rivard

An Army Mountain Warfare School student from the 10th Mountain Division climbs part of Smugglers' Notch in Jeffersonville, VT, on 18 February 2016.

sites, and airfields are all important because they are so few.

The shelter provided by a village may make it key terrain. The battle for Rzhev during the winter of 1941-1942 on the Russian plain west of Moscow illustrates the importance of shelter in cold environments and how a simple peasant village can give the force that holds it a distinct advantage. A German grenadier and artillery unit occupied the wooden houses of Rzhev. Throughout the day, the Russians surrounded the town and launched repeated attacks, each growing more desperate. As dusk approached, even sheer exhaustion did not reduce the tempo of the assaults. The Russians were less intent on killing Germans than on securing the shelter of the town, but they failed and were doomed to spend the night on the flat windswept treeless plain. Temperatures fell to -63 degrees Fahrenheit, and the winds were strong. The next morning, a German patrol dispatched to search for an escape found most of the Russian soldiers frozen in the snow; those who were alive were comatose. With the patrol's report, the German unit escaped encirclement without a shot being fired.

Mountain passes, river junctions, and dominant high ground can be key terrain, especially in the flat plains. During World War II in the battle for Attu in the Aleutians, the Japanese withdrew to the high ground on the volcanic mountains and allowed U.S. troops to land unopposed. It took U.S. units 20 days to root them out (instead of the three days they had planned), because the terrain the Japanese held dominated the flat coastal area. Soldiers of the 7th Infantry Division, pinned down in Attu's Massacre Valley, returned the fire of the Japanese snipers dug in on the fog-covered mountains, but to no avail until the battleship Nevada opened fire.

In the more moderate cold regions where the population is dense and man-made features abound, key terrain becomes more selective. A bridge, a highway junction, a tall building, a rail yard, an airport, or seaport facilities may be key.

Obstacles

Cold regions have their own unique obstacles as well as those common to other regions. Using both natural and man-made obstacles, a defending force can make offensive operations extremely costly.

The terrain channels movement, and when winter weather effects are added movement can be virtually impossible. Summer creates different but equally effective obstacles. First, in the mountainous terrain where alpine glaciers have cut U-shaped valleys, the slopes are near vertical. Slopes cut by glaciers or streams (obvious obstacles in themselves) are often too steep to negotiate with vehicles or large formations.

In the flat open plains, the wide meandering rivers are also effective obstacles. During Operation Barbarossa in World War II, the Dnieper River in Ukraine and Russia was an obstacle to resupplying the German 6th Army, which was holding a front from south of Kursk to Kharkov. All the bridges had been blown, isolating the entire army. The German 88th Infantry Division impressed local labor and built an ice bridge over the river with blocks one to three feet thick. These blocks were laid on the already frozen river in temperatures of -29 degrees Fahrenheit. The weight of the additional ice caused cracks, but water that was poured in the cracks froze immediately and acted as a weld. The completed bridge was then hosed over to make it a solid four to six feet thick. When a 130-ton locomotive was driven across it, the ice structure bowed 18 inches, but it held and provided the 6th Army with a lifeline until spring.

Lakes and marshes are natural obstacles in glaciated areas and on the plains, especially in summer. In winter, however, these features freeze over and make movement easier. Although linear glacial deposits can be obstacles, they are not usually continuous and can be circumvented.

Snow more than a foot deep immobilizes wheeled vehicles, and more than three feet of snow stops tracked vehicles and foot troops. Engineers with front-loaders can create barriers from the snow. The Canadian Army's snow berm (some three meters high and 10 meters wide and iced over on the enemy side) acts not only as an obstacle but also as a fortification. One front-loader can construct such a berm 100 meters long in eight hours, with an additional four to eight hours needed to ice over the exterior. Compact snow and ice such as this can offer cover from most direct fire. A double snow berm can stop a tank. (The two berms should be three or four meters high. The berms should have 20 percent slopes for snow and 10 percent slopes for ice.)

Snow avalanches are also hazards that are unique to cold regions. These can occur naturally in 30 percent slopes, or they can be induced at the ideal time (when the enemy is below) by artillery or demolitions.

Minefields are difficult to place in snow, and their effectiveness is uncertain. If the snow is not compact enough, it may not allow enough support for pressure mines to detonate. The employment of FASCAM (family of scatterable mines) must consider this. Magnetic and tilt-rod mines work better.

Constructing minefields in the snow also takes longer because the snow must first be compacted, or sandbags and wood bracing must be used. Laying 100 meters of mines, for example, takes two platoon hours. If a tracked vehicle is used to compact the snow, this employment time can be reduced to half a platoon hour. Trip wires may be needed because enemy soldiers using skis or snowshoes may not put enough pressure on the mines to trigger them. Claymores and bouncing betty mines are the most effective.

Mines should be used with the wire entanglements; concertina wire is quite effective in retarding ski troops. When the snow is not deep, the frozen ground is usually hard enough to permit detonation, but in the warmer months, when the ground alternately freezes and thaws, the mines can be swallowed by a quagmire of mud.

The mud itself can serve as an obstacle. During Operation Barbarossa, for example, the German 24th Armored Division was totally incapacitated by mud on the East European Plain. Although thaws normally occur in the spring, in winter (because of the lack of any land barrier) warm air from Western Europe can push the Siberian High east and temporarily thaw the black earth of Russia. Such was the case in January 1944. A three-foot thick oozing quagmire sucked up guns and soldiers' boots, sank horses to their bellies, and stopped vehicles. Almost 2,000 German vehicles were scattered across the mined route, abandoned, and later captured. The division was then ordered to road-march 200 miles north. At an average speed of one mile per hour, the lead elements finally arrived to engage and destroy three Soviet reconnaissance vehicles, the sole engagement.

Boreal and mixed forests are also obstacles. The close spacing of the trees and the thick stems prevent vehicular movement. Abatis and log barriers are ideal for reinforcing the terrain in wooded areas. In more moderate cold regions where urbanization is widespread, built-up areas become obstacles that can be reinforced by rubble.

Cover and Concealment

In the tundra, overhead concealment is nonexistent, but ground concealment in thick bushes can be quite good. Terrain masking provides concealment in some areas. In the mountains, rocks and ridges provide cover. It was in the mountains on Attu that the Japanese soldiers found hide positions and cover, while U.S. Soldiers lay in muskeg pits filled with freezing water.

In the taiga, ground concealment may be limited because of the lack of underbrush, but the thicker trees provide good

Photo by SSG Nathan Rivard

SGT Kyle Lebeau, a team leader with the 3rd Battalion, 172nd Infantry Regiment, 86th Infantry Brigade Combat Team (Mountain), supervises as Soldiers climb an ice wall in Jeffersonville, VT, on 5 March 2016.

overhead cover. Farther south, mixed forests offer similar cover and concealment. The underbrush is thicker, providing better ground concealment in the summer. Where deciduous trees predominate, winter concealment is significantly reduced as the leaves fall. In moderate cold regions, much natural concealment has been stripped away for agriculture and urbanization. Urban features, of course, provide ample hide positions for soldiers and vehicles.

Camouflage in cold regions depends upon the season. White outer garments and white-painted vehicles provide outstanding concealment in winter. The Finns used white clothing to advantage in 1939 when their ski patrols surprised and destroyed Russian columns and positions. Without snow, however, this camouflage is counterproductive, and having two sets of camouflage complicates supply and transport.

Snow fortifications can provide both cover and concealment. Compacted snow and ice will stop bullets when it is thick enough. Tests at the Cold Regions Research and Engineering Laboratory have shown that walls two meters thick will stop most small arms fire at ranges as close as 100 meters.

Concealing movements is especially difficulty on snow-covered ground. Tracks that are not covered by new or windblown snow lead directly to a position and set the scene for an ambush. Tracks also show on soft exposed soil and tundra vegetation, and tank “rooster tails” of exhaust smoke are readily visible for great distances. Noise and light discipline are also critical in the cold still air.

Photo by Alejandro Pena

Soldiers assigned to the 1st Battalion, 5th Infantry Regiment, 1st Stryker Brigade Combat Team, 25th Infantry Division, prepare for live-fire gunnery training at Joint Base Elmendorf-Richardson, AK, on 16 February 2018.

Avenues of approach are more clearly defined in colder regions. The glaciated and mountainous terrain channels movement, and the wide, marshy plains stop movement because of excess moisture in the summer and deep snow in the winter. Glacial features are linear in arrangement, and the terrain channels the movement of large forces in the direction of the glacial flow. In the scoured areas, lakes and marshes limit access routes. Mountains are usually in chains and bands separated by plains. The rugged, alpine mountains of the north preclude speedy movement. Movement is therefore confined to the plains between mountains, perhaps 100 miles across. Within a mountain chain, significant movements are channeled in the valleys. In glaciated and mountainous areas, it is clear that whoever controls the high ground controls the avenues of approach and makes offensive operations costly.

In the flat, open plains of the far north, the best avenues of approach are often frozen rivers. In summer, the rivers may still offer the easiest approach, but movements in any season are difficult to conceal. Hard-top roads are always key terrain.

Deep snow hinders trafficability by covering the terrain and hiding obstacles, ditches, rocks, stumps, and the like. Once the snow is compacted, ice makes movement treacherous. In fact, many U.S. Soldiers have lost their lives in training accidents involving ice. The first tank that drives over snow often compresses it to form ice, which endangers the following vehicles. A tank that slides on an embankment can easily overturn.

Wars that have been fought in cold regions have been among the most brutal in history. The force that adapts best to cold regions by knowing what to expect from those regions and using the various environmental influences to its own advantage will stand a good chance of winning.

BG Peter W. Clegg commanded U.S. Army Forces, Iceland, and the 187th Infantry Brigade, based at Fort Devens, MA. He previously served as deputy chief of staff for operations, 94th Army Reserve Command. He is a 1965 ROTC graduate of the University of Massachussetts and earned a master’s degree from Harvard University.

COL Robert H. Clegg commanded the U.S. Army Central Security Facility at Fort Meade, MD. He previously served as the director of the Joint Imagery Production Complex, U.S. Central Command, during Operations Desert Shield and Desert Storm. He is a 1969 a ROTC graduate of the University of Rhode Island and earned a doctorate from the University of Maryland.