8th International Conference on Military Geosciences

June 15 - 19, 2009 Vienna - Austria

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PROGRAM

ABSTRACTS

Preface

The Institute for Military Geography of the Austrian Armed Forces and the Vienna University Department of Environmental Geosciences welcome the community of military geoscientists to the 8th International Conference on Military Geosciences. This conference is the first one of this series held on the European continent – in Vienna, the capital of Austria, the very heart of Europe.

Austria is a small but beautiful country. Two thirds of it belong to mountainous areas, and that's just the reason for the special topic of this conference – "War in Alpine Regions Worldwide".

Military activities in history, but even up to the late days of the Cold War, were extremely influenced by all kinds of terrain features. Especially in the alpine regions, the defender usually was superior to an aggressor – whenever making intelligent use of the terrain. This can be shown by numerous examples of the last two World Wars. Therefore, we have emphasized oral and poster presentations and excursions dealing with special environmental conditions in alpine regions, their impacts on military actions as well as lessons learned.

This abstract volume will guide you throughout the variety of presentations provided on this conference. So it is up to you to decide to listen to a presentation, to have discussions with one of the speakers or simply to attend the poster presentations – the abstracts compiled in this booklet should make your choice easy.

Have a nice time and
Servus in Wien!

Program

Monday, June 15

0730-0830	Registration
0830-0930	Welcome Ceremony
0930-1030	Oral Presentations - Theory of Military Geosciences
MANG	Theory of Military Geography
BOULANGER et al.	Geography in French Military Doctrine since the Beginning of the 20th Century
HÄUSLER	Towards a Definition of Military Geosciences
1030-1100	Coffee Break
1100-1230	Oral Presentations - Climate Change and Geohazards
PALKA	Global Climate Change and Potential Impacts on Future U.S. Military Operations
BEHREND	Impact of Climate Change on Mountainous Regions
GALGANO	Climate Change Models and Outcomes from an Environmental Security Perspective
RAPP	Report on the Disaster Control Operation in Styria, as described by a Geologist of the Styrian Government
1230-1400	Poster Session & Lunch
1400-1440	Oral Presentation
MANG	War in Alpine Regions
1440-1500	Coffee Break
1500-1600	Information about Excursion
MANG	The Military Background
SCHRAMM	Geology of the Eastern Alps
GNASER	Organization Details

Program

Tuesday, June 16

0800-0900	Guest Speaker
GILLESSEN	The Topographic Service of the National People’s Army during the Period of the "Cold War"
0900-0930	Coffee Break
0930-1030	Oral Presentations - War in Alpine Regions and Lessons Learned 1
AUBOUT	The Geographical Interactions between an Airbase and its Environment. The Manas Airbase Example (Kyrgyzstan)
BARRETT	The Austro-German Breakthrough in the Transylvanian Alps, 1916
GELLASCH	The Caucasus Region: A Military Geoscience Overview
1030-1100	Coffee Break
1100-1220	Oral Presentations - War in Alpine Regions and Lessons Learned 2
SCHRÖDER	Mountainous Terrain and the Seven Weeks' War of 1866
BURKHALTER	A Comparison of Urban and Alpine Terrain Limitations
BYERS	Alpine Warfare at Sea Level: Battle of Attu Island (Aleu-tian Islands), May 1943
MAHANEY et al.	Terrain Evaluation Elicited from the Ancient Literature
1220-1400	Poster Session & Lunch
1400-1700	Half-Day Excursion Globe Museum

Program

Wednesday, June 17

Full Day-Excursions

H1. The Theatre of World War I in High Alpine Regions
(Austro-Italian Border)

- Transfer by bus from Vienna to the military airport Langenlebarn in Lower Austria
- Airlift crossing relevant alpine zones (Prealps, Northern Calcareous Alps, Central Alps) to the Carinthian town Kötschach-Mauthen
- Visit of the World War I Museum 1915 – 18 in Kötschach-Mauthen and the local World War I Military Cemetery
- Flight over the World War I high alpine front as far as it is identical with the actual Austrian state borderline
- Flight back across the southern Eastern Alps to Langenlebarn and transfer back to Vienna by bus.

G1. The Theatre of World War II in Alpine Regions (Semmering Area) and The Fall of the Iron Curtain in 1989

- Bus journey from Vienna to the Semmering Area
- Visit of some overlook places for detailed information on the military actions in 1945
- Coffee Breake at Maria Schutz exactly on the historic front edge between German and Soviet military forces
- Visit of the place of the “Paneuropa Meeting” of 1989 at the Austro-Hungarian border line where in August 1989 the Iron Curtain was first opened and a lot of people crossed the borderline to freedom
- Bus journey back to Vienna.

Program

Thursday, June 18

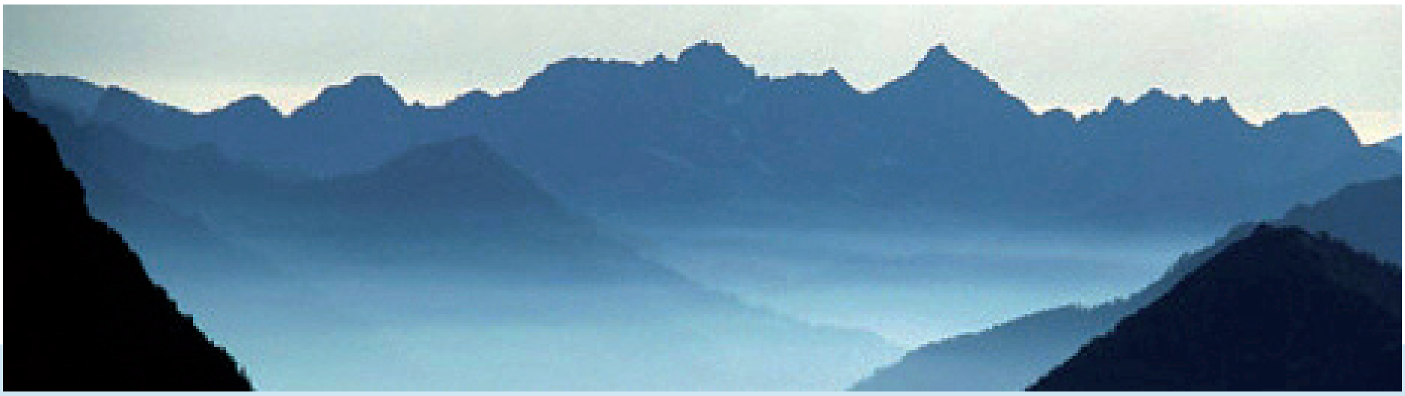
0800-0900	Guest Speaker
BARNER	The German Military Service during the Period of the "Cold War" from an Internal Director's Perspective
0900-0930	Coffee Break
0930-1030	Oral Presentations - Military Geosciences 1
BACON et al.	Predictive Terrain Hazard Maps for Military Operations in the Desert Based on Geomorphic Mapping, Remote Sensing and Soil Databases
REISINGER et al.	Trends of Strong Earthquake Activity and Military Disaster Relief
BULLARD et al.	Geology, Geomorphology, and the Vertical Dimension of the Battlefield: First ever Surrender of Major Ground Forces Unit to an Air Force – Chateauroux Region, France, August - September 1944
1030-1100	Coffee Break
1100-1220	Oral Presentations - Military Geosciences 2
WILLIG	Mining Warfare in the Wytschaete Ridge (Flanders, Belgium) 1914-19
WHISONANT et al.	Killer Carbonates: A Tour of Antietam Battlefield, Western Maryland, USA
SCHRAMM	Influence of Geology on High Alpine Warfare during World War I
ROSE	British Field Force Geologists of World War II
1220-1400	Poster Session & Lunch
1400-1540	Oral Presentations - Military Geosciences 3
HENDERSON	Harpers Ferry (West Virginia) – The Impact of Geology and Mountainous Topography on Military Operations During the American Civil War

MCDONALD et al.	Integrated Desert Terrain Forecasting for Military Operations: Geologic Basis for Rapid Predictive Mapping of Soils and Terrain Features
DOYLE	The Geology of WW II Prisoner of War Escape Tunnels
MARTIN	The Nature-Military Alliance: Nature Conservation and Military Control on the Landscape in the Post-Cold-War Era
EHLEN	Topography and Fortification: 400 Years at the Garrison, St. Mary's, Isles of Scilly
1540-1600	Coffee Break
1600-1740	Oral Presentations - Military Mapping and Surveying
BOERGER	Modern Military Geodesy
GUTH	Military Terrain Analysis Using Google Earth
BRAUN	Satellite Image Maps: How to Ensure Quality?
HAMILTON	Photographic Mapping: The British Amateur Tradition

Program

Friday, June 19

0800-0900	Poster Session
0900-0930	Coffee Break
0930-1050	Oral Presentations - Open Session
FRANZEN	Civil - Military Cooperation in Austria
TEICHMANN	Military Geo-products for the Tactical Level in International Peace Support Missions: Examples from the Dinarian Mountain Regions
BUCHROITHNER	Climate Change in High Alpine Regions – Worldwide Objective Measurements versus Conjectures
1050-1110	Coffee Break
1110-1210	Oral Presentations
MORRISON et al.	Geo-Cultural Analysis Tool (GCAT): Socio-Cultural Understanding through Urban Population Biorhythmic Modeling
HARMON et al.	Characterizing Extreme Environments for Army Materiel and Human Performance Testing
DOE III	Cold Regions and Mountain Testing and Training Areas in the U.S.
1210-1300	Closing Ceremony & Discussion
1300-1400	Poster Session & Lunch
1430-1730	Half-Day Excursion Museum of Military History
1730	End of Conference Meeting

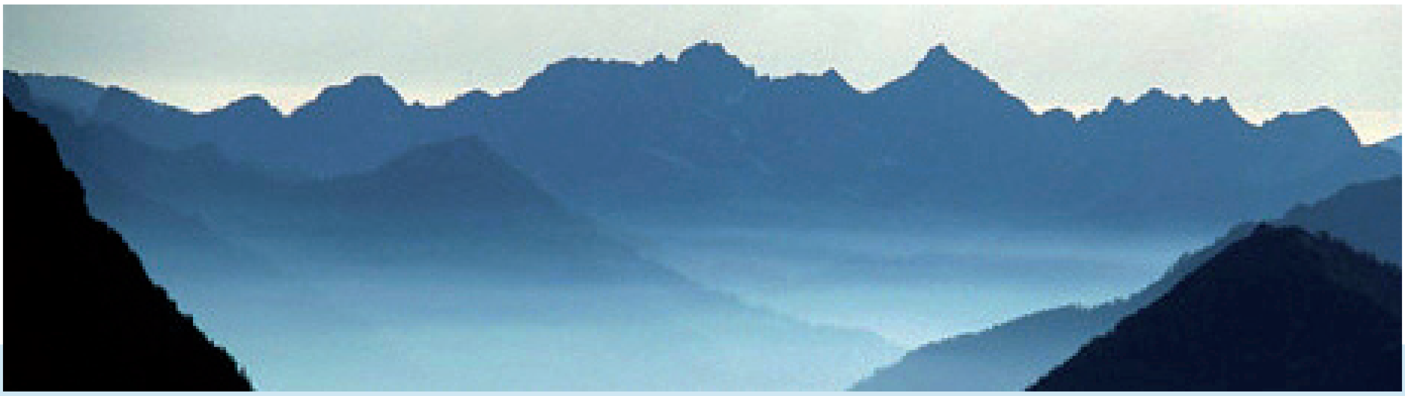


Guestspeakers

In 1989, a world historic event took place – the fall of the Iron Curtain. It began in late june, when the curtain was first opened between Austria and Hungary on occasion of the famous "Paneuropa Picknick". Since then, the world has changed its face – former enemies turned out to become partners. Formerly strictly forbidden contacts between military specialists have become everyday jobs. This also applies to Military Geography.

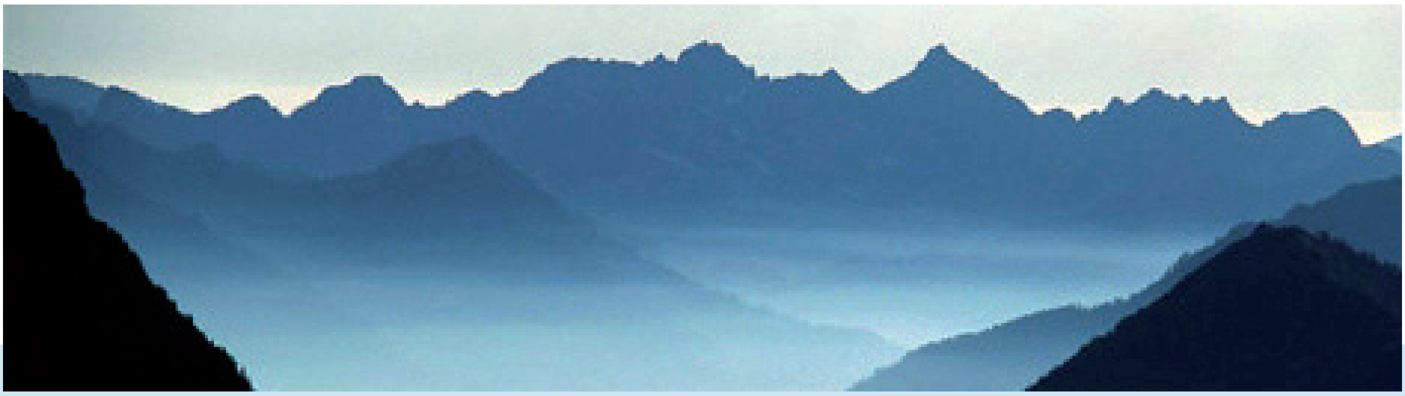
Therefore it was decided to ask two former heads of the respective Military Geographic Services of the Deutsche Bundeswehr of the FRG and the National Peoples Army of the GDR to give a report about the late politcal-military conditions, the aims of their services, the environment in which work had to take place and - of course - about their personal experiences and impressions of that period.

Col (ret.) Dr. Ulrich BARNER (Deutsche Bundeswehr, Military Geographic Service , FRG) and Col. (ret.) Dr. Werner GILLESSEN (National People's Army, Military Topographic Service, former GDR) were invited by the ICMG 2009 to give first hand information and impressions of the time before and after 1989 - information never presented before by absolutely competent persons.



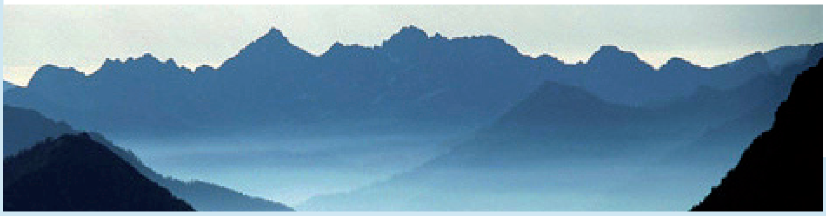
Col (ret.) Dr. Ulrich BARNER's presentation is titled "The German Military Geographic Service during the Period of the "Cold War" from an Internal Director's Perspective". Between 1989 and 1993 Barner was Chief Geographic Officer, Operations Branch, Operational- Logistics Division, Supreme Allied Headquarters Europe (SHAPE) in Mons, Belgium. From 1995 to 1997 he was head of the Bundeswehr Military Geographic Office in Euskirchen, Germany.

Col. (ret.) Dr. Werner GILLESSEN's presentation is titled „The Topographic Service of the National People's Army during the Period of the "Cold War"". Between 1988 and 1990 Gillessen was head of the Military Topographic Service in the Ministry of National Defense in Straussberg. After his transfer to the Deutsche Bundeswehr in 1990, he supported the building of new military geographic structures (comprising personal, material and organisation) in the new federal counties of reunited Germany including special relations to the new surveying offices in the new federal counties.



Abstracts

Oral Presentations &
Poster Presentations
in alphabetical order



The Geographical Interactions between an Airbase and its Environment. The Manas Airbase Example (Kyrgyzstan)

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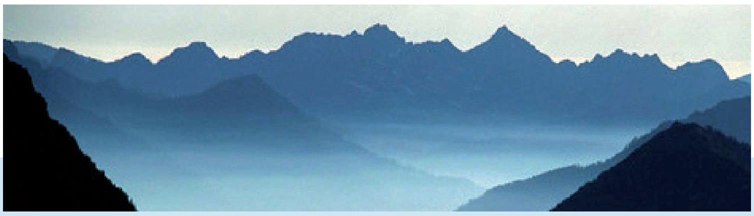
Oral presentation

Knowing physical and human geography has always been one prerogative of the military forces. Indeed the knowledge of the geographic characteristics is a key for the military operations. Concerning the air force, only the specificities of the atmosphere are usually considered. Being acquainted with meteorological, aerologic or relief characteristics gives essential information for flying or targets treatment. Today, however, the technological development permits aviation to free itself from atmospherics constraints and visual landmarks. But, what remains constant is that all aircraft depend on an airbase.

Sure enough, military operations that require a projection of force or power through the 3rd dimension also need a base on the ground. The efficiency of air power also results from the airbase characteristics. The airbase has a real spatial print influenced by physical geography and human geography. An air base and its environment constitute a system of systems with its own organization and internal interactions. As the "action and reaction" physical principle, the environment acts upon the airbase and conversely.

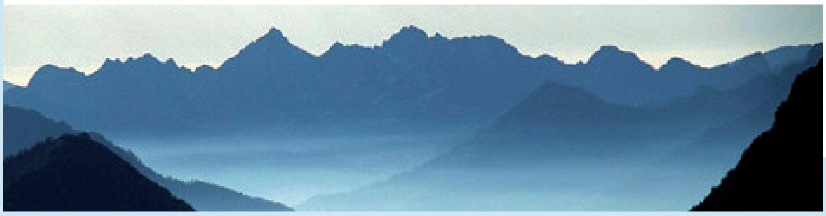
The study of the Manas Airbase, in Kyrgyzstan, is an interesting example. A coalition airbase for military operation in Afghanistan since 2002, Manas airbase is influenced by political, economic and cultural environment. It also acts upon its environment on several scales. Since the airbase creation, economical or geopolitical data have changed.

My presentation will focus on the analysis of the interactions between an airbase and its environment during the first years of its setting up. I will put forward the increasing importance of the airbase as a local economic actor, for instance, through the renting of the land and the employment of numerous Kyrgyz people. On a geopolitical scale, the setting-up of an airbase made Chine and Russia change their policies towards Kyrgyzstan. Vice-versa, the factors such as distance between the airbase and Afghanistan, the relief, the climatic conditions have impact on operational



military missions and consequently influence the airbase organisation.

The aim of this presentation is to demonstrate the importance of military geography for the installation of an airbase in a foreign country.



Predictive Terrain Hazard Maps for Military Operations in the Desert Based on Geomorphic Mapping, Remote Sensing and Soil Databases

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Graham DALLDORF [1],
Sophie BAKER [1],
Don SABOL Jr. [1],
Tim MINOR [1],
Scott BASSETT [2],
Shawn MACCABE [1],
Tom BULLARD [1]

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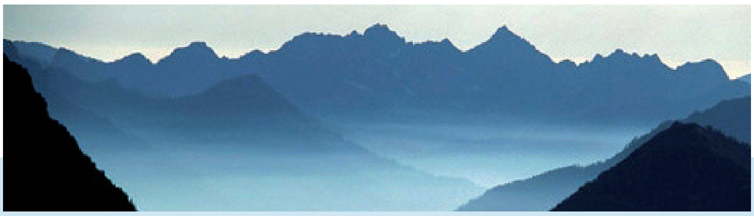
Oral presentation

We present an expert based system to rapidly predict the shallow soil attributes that control dust emission, as well as other terrain hazards in the arid southwest U.S. Our system's framework integrates geomorphic mapping, remote sensing, and the assignment of soil properties to geomorphic map units using a soil database within a geographic information system (GIS). This expert based system is based on soil state factor-forming model parameters that include: (1) climate data; (2) landform; (3) parent material; and (4) soil age. The four soil-forming data layers are integrated together to query the soil database. The result is a base map showing geomorphic units that are assigned a hazard class rating from Very High to None to generate a terrain hazard map.

To validate the accuracy of the expert based model and resultant predictive terrain hazard maps, a blind test was performed at Cadiz Valley in the Mojave Desert, California. The desert terrain in Cadiz Valley consists of alluvial fans, sand dunes, and playa features. The test began with three users independently mapping an area of over 335 km^2 using 1:40,000-scale base maps to rapidly create geomorphic and age class layers, and then integrating these with climate and parent material layers. The results of the four data layers were then queried in the soil data base and soil attributes assigned to map unit layers. The soil-forming model presented here is geomorphic-based, and considers soil age as a significant factor in accurately predicting soil conditions in hyper arid to mildly arid regions. This work comprises a successful first step in the development of an expert-based system to generate a variety of predictive terrain hazard maps, from dust and salinity emission potential maps to mobility hazard maps, in an effort to assist with military operations in remote desert regions that lack existing soils information.



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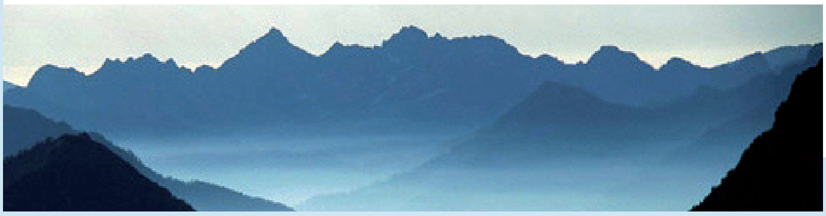

The Austro-German Breakthrough in the Transylvanian Alps, 1916

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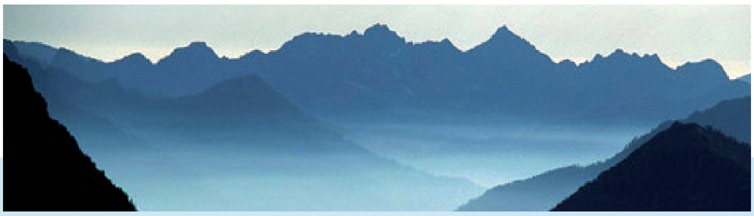
Oral presentation

Romania's entry into the war in late August, 1916 caught the Central Powers off guard. With their troops tied down by Allied offensives in France, Russia and Italy, they could only watch impotently as Romanian infantry swept over the crest of the Transylvanian Alps and descended into the lush Siebenbürgen region of Hungary.

Pushing the Romanians back across the mountains posed serious problems. Not only did the enemy hold the high ground and the few passes deserving of the name, but Transylvania lay at the extreme southeast edge of Austria-Hungary and was serviced by only two tattered and feeble rail lines, both of which ended in ruins at the Romanian border. On the Hungarian side of the frontier, mountains rose abruptly from heavily wooded regions to alpine meadows, beyond which reared bare peaks threaded by narrow pathways inimical to military traffic. One river, the Alt, traversed the mountains from Hungary into Romania.

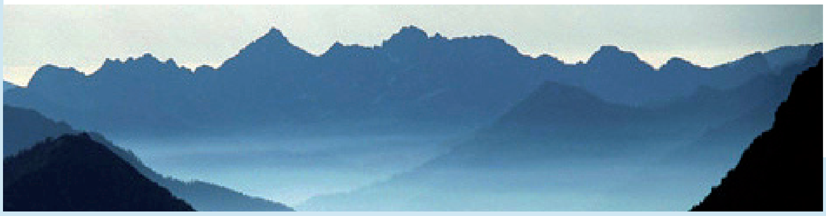
As if a poor military situation, unfavorable logistics and hostile geography were insufficient, the weather conspired against the Central Powers as well. Heavy snows came early in the Transylvanian Alps, preventing movement by late October. The specter of yet another front opening at the furthest extremity of their lines of communication, draining men and materiel, threatened to bring down Austria-Hungary, thus it was imperative that the Romanians be crushed before winter weather closed the mountain passes until the spring.

The Austrians and Germans cobbled together a force composed of battered divisions from the Western and Russian fronts, reinforced by locally-raised battalions of coal miners. The general named to lead this hastily assembled force over the mountains was Erich von Falkenhayn, hardly a person to inspire confidence, since he had just been sacked as Chief of the German General Staff.



As the weather closed in, Falkenhayn mounted a thrust in late October, penetrating the Romanian lines at the Vulkan and Szurduk Passes, rolling up the flank of the Romanian army, and sending it reeling towards Bucharest. Joined by a German-Bulgarian force advancing across the Danube, the Central Powers drove the Romanians into Bessarabia, decisively ending the campaign in early January.

Falkenhayn's 9th Army, a mix of Austrian and German units, and its breakout over the mountains in the face of strong Romanian resistance, unfavorable geography, primitive logistics, and deteriorating weather conditions illustrate the feasibility of combat in high alpine regions, where strategists prior to the war had not anticipated influential military action. This paper will examine that effort. What makes this campaign important is that unlike the alpine combat in Italy in 1915-1916, the Austro-German forces in Romania proved that they could conduct a decisive campaign in alpine regions.



Impact of Climate Change on Mountainous Regions

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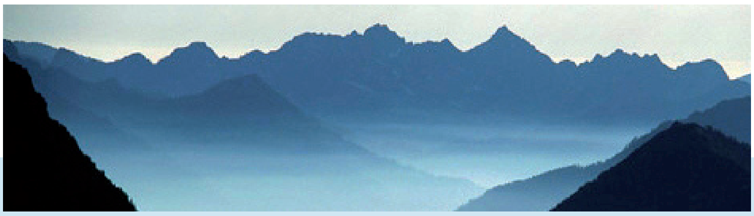
Oral presentation

Mountainous regions are affected by climate change not only through increasing temperatures and changes in the pattern of precipitation, but also by the melting of glaciers and the reduction of snow cover. The shrinking glaciers are changing the runoff of the rivers considerably. First, the runoff is increasing but later, when the size of the glacier has reduced beneath a critical size, runoff is decreasing - most during the dry season. Further impacts are the increase of landslides along the slopes by melting frost and heavy rainfall.

The change in the runoff of rivers fed by the glaciers of big mountain chains is critical especially for the Himalaya mountains and the Andes because roughly 20% of the world population is living within the river basins which are fed by the glaciers of these mountain chains. It is expected that the runoff of these rivers will increase during the next 2-3 decades and reduce dramatically afterwards. During the dry season, it will already reduce very soon in many regions. This will have a huge impact on the nutrition of a significant fraction of human beings and might lead to migration and thus collapse of nutrition elsewhere. That impact has been considered as the most serious impact of climate change to security.

An example for the impact of climate change on mountainous regions is the decrease in water availability within the Ama Darja Basin where the rivers of the Northern part of the basin are fed by the Himalaya Mountains. In that region, the climate is almost dry with significant amounts of rainfall only occurring during winter and spring. Currently, precipitation amounts are already decreasing in that region and are projected to further decrease during the next few decades. The runoff of the rivers in the Northern Part of the basin will decrease much more than precipitation amounts because of the shrinking of glaciers. This will have a tremendous impact on the population, which has already a very low standard of living and is decreasing rapidly.



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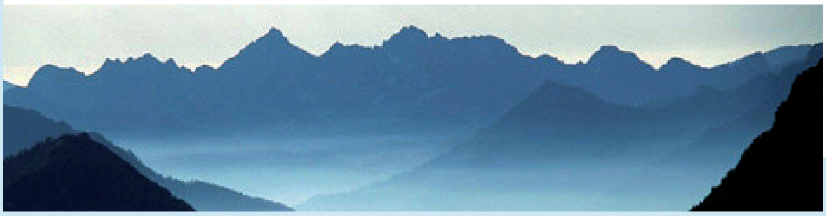

Modern Military Geodesy

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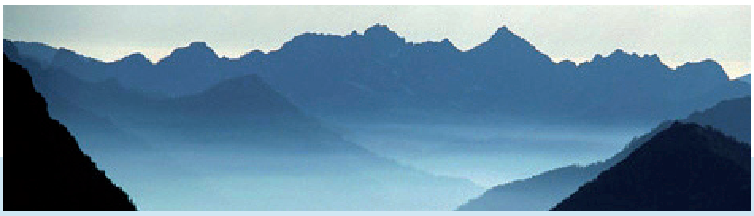
Oral presentation

An essential military capability is the “positioning, navigation and timing” which is abbreviated and well known as PNT. Nowadays and at a first glance PNT seems to be an easy matter, but in the last years the army’s tasks have changed basically and with this the requirements on PNT. Today an army is not restricted to national defence only, but international activities by order of the United Nations and therefore worldwide missions are growing. Thus a “Global PNT” is required, and associated with this are different geodetic aspects, e. g. geodetic fundamentals and geodetic applications. Fundamentals are adequate global reference systems and global reference frames for horizontal and vertical positioning as well as reference systems and reference frames for timing. Based on this the user applies different methods of surveying and navigation. But a Global PNT, taking into account the requirements of all forces, i. e. army, navy and air force, is exacting with respect to geodesy, and a Global PNT raises new questions and problems. This contribution picks up and argues particular geodetic challenges, which come up with a Global PNT.



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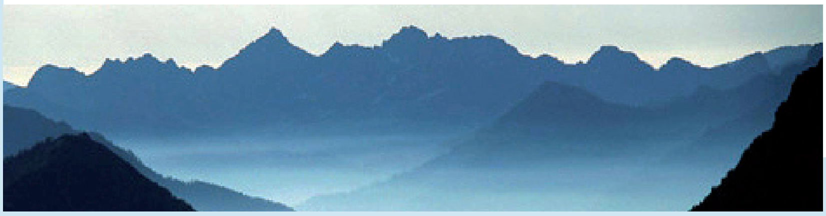

Geography in French Military Doctrine since the Beginning of the 20th Century

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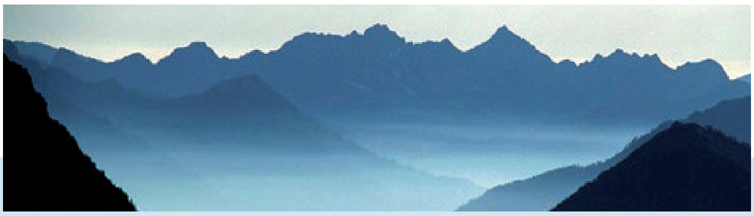
Oral presentation

French Military geography developped an original movement of thinking during the XIXth century. A lot of military geographers, like Anatole Marga, Léon-Gustave Niox or Robert Villate, proposed some concepts to bring a new military thinking between 1871 and 1939. But French military army doctrine did not follow this movement. It had to wait for the First world war to have a veritable geographic consideration. Every physical and human influence of geography is considered of manner to prepare, conduct and exploit a military operation. Those influences may be studied as for armaments and spatial technologies, training and survival of the units, composition of the units, maneuvers. In the origin of military geography in the doctrine, especially in the military instructions, operations were conceived of a rural country against German armies until 1945, Soviet armies after 1945, terrorists and rebels troops and conventional army since 1990. The French army doctrine became more rational after 1918. Some new types of space are studied as mountains, forest, humid and desertic tropical countries, or urban space. This thinking evolutes with the evolution of societies, geostrategy of the world, development of technologies. What are the dimensions of geography in the French army doctrine since the First World War?



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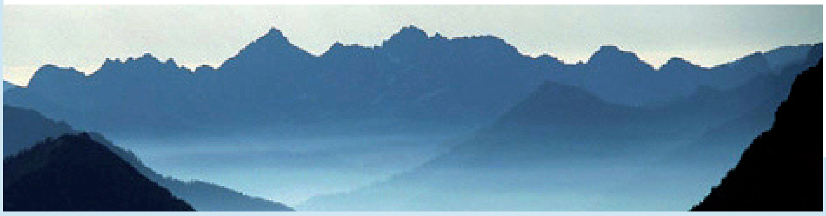

Satellite Image Maps: How to Ensure Quality?

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Oral presentation

The Bundeswehr Geoinformation Office (BGIO) supplies quality controlled geoinformation to the German forces including satellite imagery products.

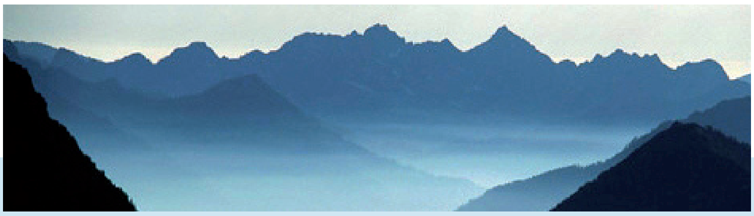
Since several years high resolution space imagery has been in competition with aerial photography for many mapping applications. High resolution satellite images from SPOT5 (10m GSD), IKONOS (1m GSD), QuickBird (0,6m GSD) or WorldView1 (0,5m GSD) serve as input to derive orthoimages in National or International Map Projections with an overall accuracy described by the Root Mean Square Error (RMSE) in each direction. The topographic reference are the world wide digital elevation models (DEM) from SRTM-C band Version 2, SRTM-X band and SPOT-DEM. In order to achieve the required accuracy and to correct the exterior orientation parameters or the Rational Polynomial Coefficients (RPC), Ground Control Information (GCI) i.e. Ground Control Points (GCPs) need to be identified in new satellite scenes.

The geometric potential of this imagery usually is satisfying but it is also necessary to pay attention to the quality of system operators preprocessing.

Generally quality assessment is based on manually or automatically extracted GCPs from which mean RMSE values for each satellite scene are derived and from which residual plots can be produced. The precondition is that sufficient ground control of a higher quality is available for an independent quality assessment.

Sufficient GCI, however, is frequently not available in many regions of the world neither on the military nor on the civil side. In this case accuracy assessment can only be based on best available knowledge about the satellite orbit, the stability of the sensor and the elevation differences in the terrain, especially in rough terrain in alpine regions.

The paper gives an overview over common orthorectification processes and their limitations, and presents examples to overcome problems of insufficient Ground Control Information.



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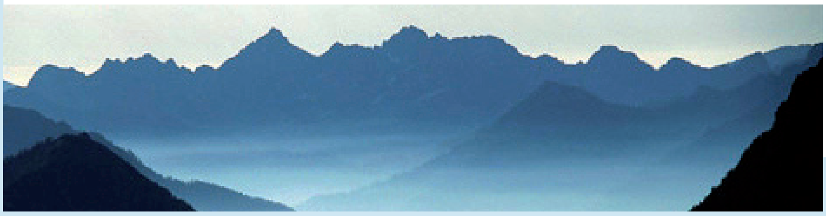

Climate Change in High Alpine Regions – Worldwide Objective Measurements versus Conjectures

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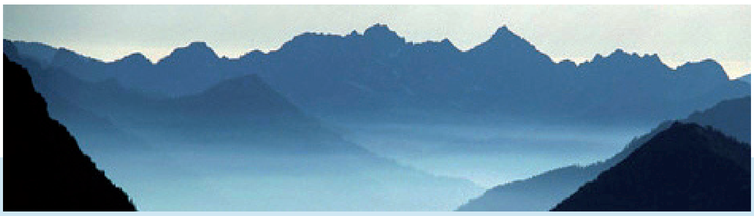
Oral presentation

Using examples from different high mountain ranges of the world, objective environmental showcases concerning the shrinkage rates of glaciers are given. Since glaciers also reflect the annual snow- and, hence, water household, they are well-established climate indicators in high-alpine terrain. Dating back to the middle of the 19th century, sufficiently accurate maps displaying the actual extension and thickness of glaciers are for instance not only available from the Alps (Brunner 1987, Bruhm et al. 2009) but also from the Himalaya (Bhambri & Bolch 2009). Examples from the research activities of the authors in the Chilean Atacama Andes (Eydam 2009), the Canadian Rocky Mountains (Bolch et al. 2009), the Western (Bernina Massif, Bolch 2008) and Eastern Alps (Dachstein Massif, Bruhm et al. 2009), the Northern Tian Shan (Bolch 2008), the Nepalese Himalaya (Mt. Everest Massif (Bolch et al. 2008) and the Nyanchen Tanghla Range in Southern Tibet (2009, unpunbl.) are mainly based on historical air- and multisensoral spaceborne remote sensing data and in some cases also comprehend figures about the downwasting rates.

The latter ones represent the truly interesting facts, since they are based on multi-temporal glacier morphology indicating the volumetric changes. An example of stereo-restitution of the previously classified U.S. Corona (KH-4) intelligence imagery from 1962 applied to Mt. Everest's Khumbu Glacier is also given. All these data can serve as an objective short-time database for long-term modelling. If for definite statements regarding the future of the regional cryospheric and climatic developments these time-series are sufficient may still be questioned. In any case, data acquired by recent very high-resolution passive (e.g. WorldView) and active (e.g. TerraSAR-X) satellite sensors allow rather exact quantifications of glacier volume changes.



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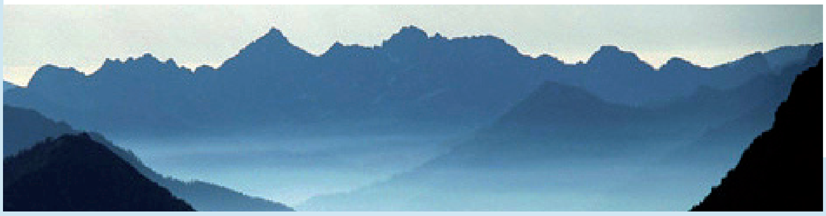

Geology, Geomorphology, and the Vertical Dimension of the Battle-field: First ever Surrender of Major Ground Forces Unit to an Air Force – Chateauroux Region, France, August - September 1944

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Oral presentation

In August 1944, when Allied forces pushed east from Normandy toward Paris, aerial reconnaissance missions were flown south of the Loire River in central France (Berry region) to protect the exposed southern flank of Patton's Third Army.

Massive numbers of German troops and armor rapidly withdrawing from southern France faced little resistance to their escape.

However, their smooth egress was hindered by the complex topography of the Loire basin and Tertiary geology underlying the southern Paris Basin.

Continual harassing attacks by the Maquis and French Resistance (FFI), and topographic bottlenecks helped to slow the German retreat resulting in long columns exposed to daylight aerial attack.

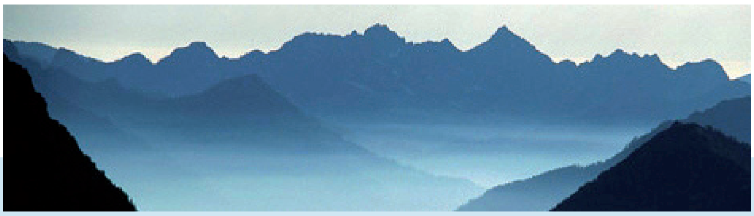
Armed reconnaissance squadrons from the 36th Fighter Group (9th U.S. Army Air Forces) discovered the German forces fleeing through a topographic gap in the Poitiers, Châtellerault, Chateauroux, Bourges, Clamecy area.

Dawn-to-dusk missions from August 30 to September 7 were flown by 36th and 406th Fighter Group squadrons from Allied airfields near Brucheville, Le Mans, and Loupeland resulting in destruction of more than 1000 vehicles, transports, tanks, supply trucks, horse drawn guns, as well as hundreds of German troops.

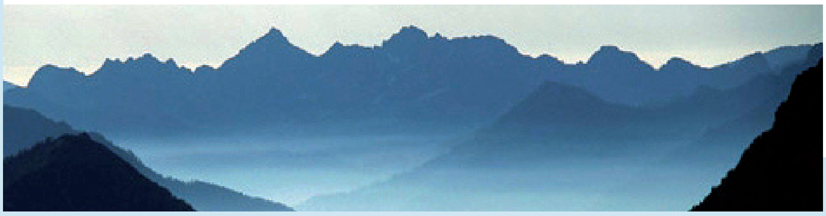
General Major Botho Elster of the LXIV Armee Korps sent a message via the FFI to the Allied command offering to surrender along with more than 18,000 troops under the condition that air attacks cease.

This marked the largest single surrender of German troops along the western front. With the help of the FFI, this also was the first time in military history that a major enemy unit had surrendered to an air force.

The event served to emphasize the growing importance of the tactical linkage between ground forces and air support, thereby extending the vertical dimension of the



battlefield and at the same time highlighting the role of the landscape and geologic framework in battlefield strategy.



A Comparison of Urban and Alpine Terrain Limitations

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Oral presentation

Recent research efforts have focused on the development of military hardware, software, and tactics, techniques, procedures (TTPs) for use in the urban battlespace. Global urbanization trends and the US military efforts in Iraq have motivated theorists and practitioners to focus on this 'new' terrain space.

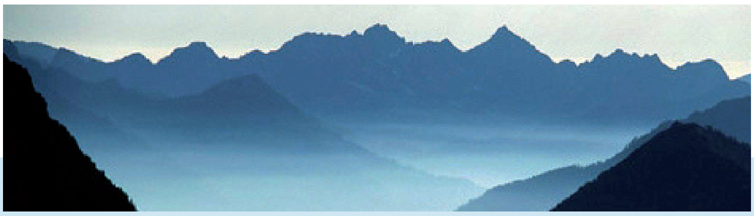
The advances in TTPs, civil considerations, and intelligence, surveillance, reconnaissance (ISR) platforms have contributed, over the last 5 years, to a more comprehensive 'urban awareness'.

The implementation of new policies, hardware, and TTPs in Iraq have improved security, reduced casualties, and engendered the more efficient utility of force.

This experience has cultivated a body of experience in urban terrain, but this does not represent the full complement of potential locales for warfare. The conflict in Afghanistan has highlighted the challenges inherent to engaging opponents in alpine terrain.

While the US Army retained some at least notional specialized mountain forces, these assets are insufficient to resolve a significant (in either size or duration) conflict. It remains to be seen if traditional alpine TTPs are sufficient in the 21st century, or if years of research and practice are required to develop the same level of competency in the mountains as is currently demonstrated in urban areas.

This paper seeks to compare and contrast the terrain limitations imposed by both urban and alpine environments. Furthermore, it is hoped that similarities identified in the respective environments would enable the swift adaptation of proven TTPs. In essence, can the years spent learning how to utilize force in cities contribute to improving how force is utilized in the mountains.



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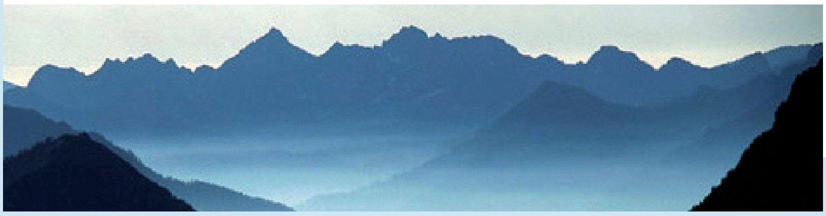

Evidence of Conflict in the Contemporary Built Environment: A Case Study of a V1 Bomb Site in London

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Poster presentation

From September 7, 1940, when the first force of German bombers attacked the docks and the East End, until March 27, 1945 when the last V2 rocket landed in Stepney, London was an area of conflict; effectively a battlefield. Despite the fact that the majority of buildings in the city suffered damage that ranged from broken windows to complete obliteration, today there is little apparent evidence of the battle remaining. Time has healed London's wartime scars; bomb damaged buildings have been re-built or demolished and replaced by modern buildings. In some cases, vast areas were cleared for redevelopment in line with Churchill's view that the persistance of wartime damage was to be debilitating to morale.

If visitors can no longer see the evidence of the battle how do they know they are witnessing a battlefield?

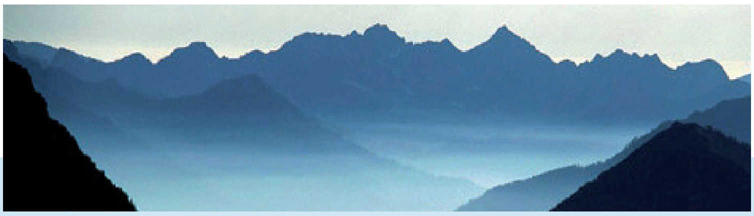
Our work demonstrates that with appropriate resources and careful analysis, it is still possible to view the evidence of battle.

In order to demonstrate this we examined a geographically-constrained site in London, in order to identify evidence of the battle within the contemporary built environment.

The site is a small area of the present London Borough of Camden, where, on June 19, 1944 a V1 flying bomb – the first of Hitler's 'revenge weapons' with largely random targeting – exploded. The built environment around the bomb site was predominantly 18th century in origin and included many streets of terraced town homes. The destruction caused by the bomb affected five streets and damaged, to some extent, 67 buildings. The site is now part of the Charlotte Street Conservation Area.

Changes to the built environment that have occurred since 1945 are identified through site analysis and study of archival sources.

During the Second World War the London County Council's Architects Department hand colored Ordnance



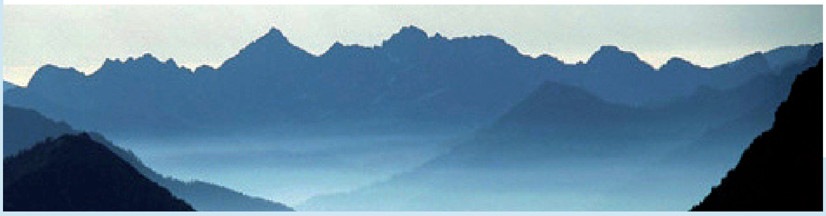
Survey maps to show the category of damage that occurred to buildings as the result of bombing. It is hypothesized, that changes to the built environment that have occurred since 1945 were affected by the category of damage caused by bombing during the war, with those buildings destroyed by bombing replaced by new buildings and the lesser damaged buildings being repaired.

Three separate analysis of the site were conducted to identify evidence of the attack on 19 June 1944:

- Identification of the conditions before the Second World War.
- Examination of bomb damage recorded after 19 June 1944.
- Assessment of current conditions and evidence of attack.

The results of the analysis support the hypothesis.

The narrow Coleville Place is an excellent example of how the evidence of battle can still be seen in the contemporary built environment; it is hoped that this survey can be used to inform planners and conservationists interested in the development of conservation strategies for the historic fabric of the City, preserving a layer that illustrates one of the most important points in the history of London, and Britain as a whole."



Alpine Warfare at Sea Level: Battle of Attu Island (Aleutian Islands), May 1943

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Oral presentation

Alpine warfare differs from conventional warfare in many ways, including difficult terrain, harsher climate, and strategic and logistical challenges, which directly affect the mentality of men and the role of leaders in battle. In addition, positions in mountainous terrain are more easily defensible and more difficult to attack.

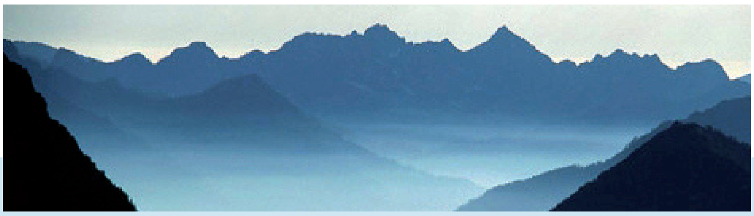
These many factors are almost universally reflected in the Battle of Attu Island, one of the Aleutian Islands, fought from 11-29 May 1943. The terrain, though remaining below 1000 m, posed many of the same challenges as mountainous terrain in the rest of the world, including precipitous crags, snowcapped peaks, and flat rock faces.

Soldiers on the ground, not trained for mountainous warfare, had to contend with persistent fog, soggy tundra, frequent storms, and constant dampness of the environment. Poor conditions delayed the initial attack by four days.

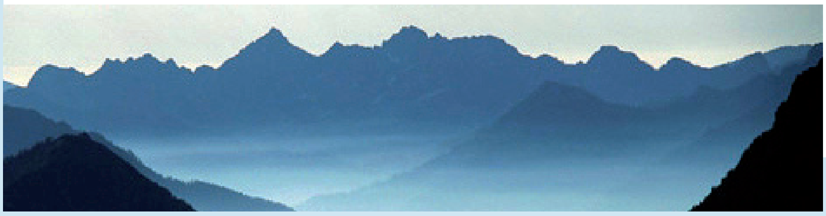
Those same weather conditions severely limited combat support and logistics of naval and air units, creating semi-isolated combat conditions for the ground troops. The American military knew almost nothing about the topography of the island, aside from a rough map showing the shoreline and a few aerial shots through the fog.

Because of the lack of intelligence before the attack, logistics and communication were extremely inadequate during the battle. Roughly 2400 Japanese successfully defended Attu from 15,000 Americans for almost three weeks by utilizing vantage points located over the passes within the mountains.

Soldiers involved in retaking Attu encountered and overcame many of the same challenges presented by the environment and nature of alpine war-fighting faced in hostile mountainous areas of the world today. While Attu Island does not fit the traditional definition of alpine war-



fare, a case study of the battle of Attu Island provides many important insights into alpine warfare and warfare under difficult environmental and meteorological conditions.



The Wall Maps of the Alps (1882) by Vinzenz von Haardt

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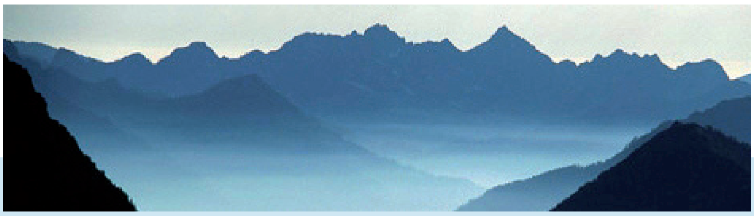
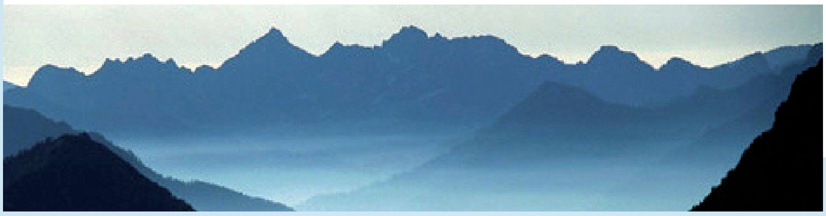
Poster presentation

Vinzenz Haardt von Harthenthurn is an outstanding personality in the history of Austrian cartography. Born in 1843 in Jihlava, Moravia as the sixth child of a family coming from a long line of military distinction, he already receives military training at a very young age. As a cadet at the Theresian Military Academy in Wiener Neustadt he is trained in cartography and military cartography by (among others) Carl von Sonklar, an expert in military cartography himself. He fights in the war in Italy in 1866, and is appointed to join the General Staff later. He works for the description of the country of Dalmatia. In 1873 he resigns from the military and becomes head of the cartographic department of the renowned Viennese publishing house Eduard Hölzel in 1877. As such he is responsible for various editions of the Kozenn-School Atlas which has continued to be printed and in use until very recently; furthermore, he edits a variety of other atlases used in different schools and written in different languages of the monarchy. A complete set of wall maps of all continents for schools and his maps showing the Polar Regions are also well-known abroad.

A very climax of cartography is his wall map of the Alps (1:600.000, 1882) in different editions (detailed, school, mute) with various usage of vertical and oblique illumination. Hand maps of the Alps with hardly any modifications are published till 1915. In particular the description of the Alps has a high priority in the cartography of the empire of the Habsburgians and reaches a climax in the so-called Hauslab´sche scala by Franz von Hauslab (about 1830) and the Wiener Schule. In 1873 a hypsometric overview-map of the Alps (1:1,7 Mio.) is published by Anton Steinhauser. Haardt becomes one of the most influential editors for school geography in his time; his principles of the methodology of designing wall maps have been valid to this day. Vinzenz von Haardt leaves the publishing house Eduard Hölzel in 1896 and starts working for the department of military geography. He represents the department at various international conventions. In this period his articles on



the history of the department of military geography and the history of cartography (focussing on the Balkans) emanate and are worth to be mentioned aside, as they have been used as reference works ever since.



Cold Regions and Mountain Testing and Training Areas in the U.S.

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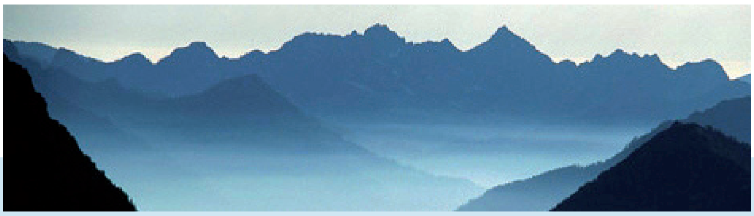
Oral presentation

Since the early 1940's, the U.S. Army has trained soldiers and units in mountain (alpine) and winter warfare for these unique and difficult operational environments. The American Army's experience in combat in these environments includes the Battle of Attu, Alaska in 1942 and current operations under Operation Enduring Freedom in Afghanistan. There is a rich and complex history and geography to where the Army has established its places and training areas for mountain and winter warfare. For example, the establishment of Camp Hale in the Colorado Rocky Mountains from 1942-44 was a brief but important episode in this history and geography, that still has a physical and environmental presence today. The soldiers who trained there returned after World War II to develop the commercial ski industry in Colorado which is one of the State's dominant economic enterprises.

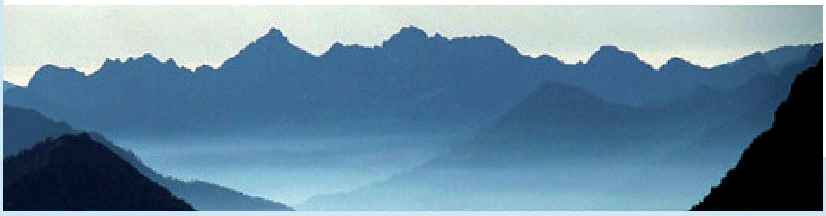
Today the Army operates the Northern Warfare Training Center in Black Rapids, Alaska to train soldiers in mountaineering and glacier operations. The Army has also established research and testing organizations and centers, such as the Cold Regions Research Laboratory and the Cold Regions Test Center, to address cold weather and mountain requirements for equipment and vehicles. The temporal and spatial legacy of mountain and winter warfare has been complicated by organizational structures, proponency and mission relevance as the Army has evolved from World War II to the 21st century.

The development and eventual disbandment of organizations such as Mountain Training Groups, Light Divisions (Alpine) and Mountain Divisions reflects this complexity.

The American Army's experience, history and geography with training soldiers for mountain and winter warfare has reflected a tension within the Army of specialization versus standardization of soldiers, units and equipment.



These complexities and tensions will be analyzed and discussed to provide the American Army's perspectives on training and warfare in alpine regions.



The Geology of WW II Prisoner of War Escape Tunnels

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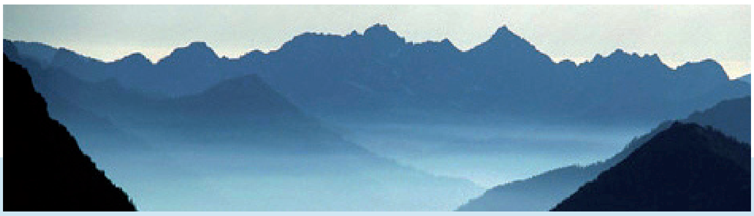
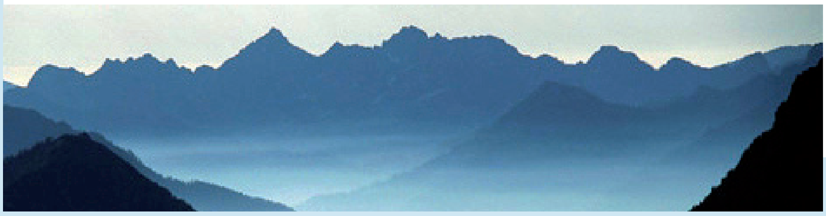
Oral presentation

During the Second World War a total of 164,000 Commonwealth and 95,000 American soldiers, sailors and airmen were to become prisoners of war in Germany. The Geneva Convention also laid down the basic parameters for prisoner of war camps. Commonest were the large hutted compounds housing other ranks known as Stammlagern or Stalags. Officers' camps, Offizier-lagern (Oflags) were usually more varied in type; from hutted camps to castles and regional palaces pressed into use. The most famous 'Schloss' camp was Oflag IVC, based at Colditz in Saxony; a forbidding 900-year old castle used as a Sonderlager, or special camp, for committed escapers and 'enemies of Germany'. Air force personnel would be housed in hutted compounds (Stammlagern-Luftwaffe or Stalags Luft) specially constructed on the orders of Reichsmarshall Herman Goering and run by the Luftwaffe for captured Allied airmen. These compounds grew progressively throughout the war. Naval personnel were held throughout the Reich in a wide variety of camps, as well as in the special Kriegsmarine-run camp (Marine-Lager) at Westertimpe, with two adjacent compounds, Marlag (O) for officers, and Marlag (M) for other ranks. Merchant seamen would be interned as civilian prisoners at the adjacent Milag (Marine-internierten-lager).

Escape from most POW camps required ingenuity, luck, hard work and planning. Tunnelling out is seen as a classic form of escape, and it was attempted in most camps. The success of tunnelling was at the mercy of the ground conditions as well as the vigilance of the security staff, and was a triumph to the ingenuity of the tunnellers themselves. Geology was a major control on escape, and camps were sometimes placed to take advantage of the local geological conditions. Stalag Luft III, in Silesia (now part of Poland), was an air force camp located to discourage tunneling by the presence of bright yellow sub-soils that would demonstrate the presence of the diggings to the captors. Con-



versely, the presence of unlimited sands meant that digging was easy, the main preoccupations being the ability to dig deep to avoid detection, the disposal of spoil, and the availability of materials for shoring. At Oflag IVC in Saxony, the camp was an ancient Schloss built on a sill of Rochlitzer porphyry tuff. Extremely hard, and with little soil development, tunneling in this camp was severely limited, although it was tried, with limited success. Using these and other examples, this paper will discuss the influence that geology had on tunneling for escape and of the effectiveness of the camp situation in foiling such attempts.



Topography and Fortification: 400 Years at the Garrison, St. Mary's, Isles of Scilly

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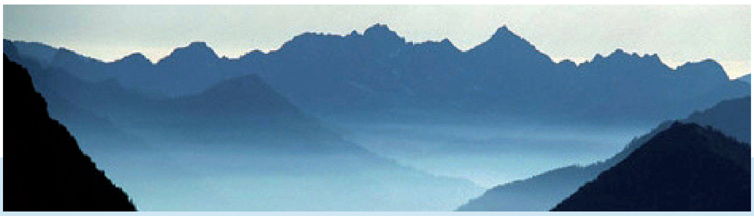
Oral presentation

The Isles of Scilly, the western-most exposure of Britain's Cornubian batholith, are strategically positioned 28 miles west of Land's End on the coast of Cornwall, England. Located where major shipping routes intersect, they guard access to mainland Britain by sea from the Atlantic Ocean, and the Irish, Bristol and English Channels. Over the years they have been invaded by the Spanish and the Dutch as well as having experienced several engagements during the English Civil War and numerous incursions by marauding privateers and pirates of various nationalities. Because of this history and their strategic position, the islands have been fortified for more than 400 years. Most fortification occurred on The Hugh, a high hill that overlooks sea access to all of the islands, on the western side of St. Mary's, the main island in the group. Because of its military function, this hill subsequently became known as The Garrison. Fortification occurred in fits and starts, depending upon the military threats of the day, but primarily in four periods: late 16th century during the final years of the reign of Queen Elizabeth I, during the English Civil War in the mid-17th century, in the 18th century due primarily to the Spanish Wars, and at the beginning of the 20th century.

Finally, adaptions to the earlier fortifications were made during both World Wars I and II, after which The Garrison was abandoned for military use. The positions of new, extended or adapted fortifications moved up the steep granite slopes of The Hugh reflecting weapons technologies and functions as well as military needs of the day. This paper will describe the development of fortifications at the Garrison since the late 16th century and show how the weapons technology of the day controlled their positions.



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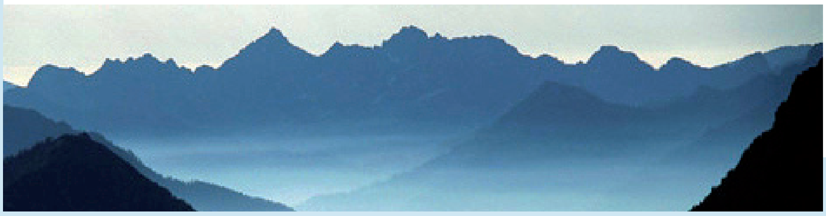

Military Geographical Mountain Information in Austria

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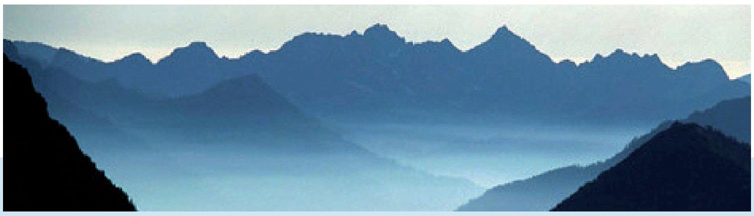
Poster presentation

Up to the middle of the 19th century military geographical information about mountain areas was not used because warfare in mountain regions was out of question for strategic and operative planning in Central Europe. Because of military interests there were only opportunities of passing mountain areas with own troops (infantry, cavalry, ordnance-troops) as well as blocking such movements by enemy forces with weaker own troops. Five examples from Austrian military history will be presented:

1. Bosnia-Herzegovina 1878-1908 (topographic maps 1 : 75,000 without a military grid),
2. World War I at the southwestern theatre of war in Carinthia and Tyrol 1915-1918 (different thematic military geographical maps),
3. Interwar period 1920-1938 and World War II 1941-1945 (topographic maps with a military grid, panorama-drawings, caves),
4. Allied occupation period 1945-1955 (French summer- and winter-map 1 : 50,000) and
5. Austrian Armed Forces information during the Cold War period 1955-1990 (orthophoto-based maps 1 : 10,000/5,000 edition alpine and some thematic handcolored maps of alpine infrastructure).



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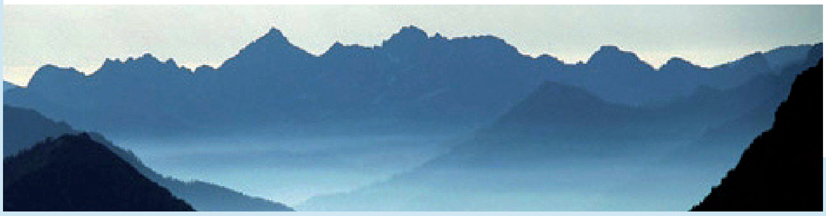

Civil - Military Cooperation in Austria

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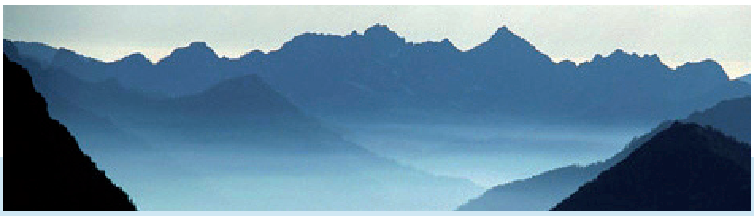
Oral presentation

Systematic topographic mapping in Austria goes back to the 18th century. From 1764 up to 1918 cartography was a task of the armed forces. Within this period the whole territory of the monarchy was mapped three times. After World War I the former “Institute of Military Geography” was put under civil administration as federal company “Cartographic Institute”. At the beginning of World War II civil cartography and civil geodesy were merged and put under military administration. After the end of the war the Austrian “Federal Office of Metrology and Surveying” was founded. From this time on the division “Land Mapping” was responsible for civil and military mapping. In the last decades civil and military maps became more and more identical and geoinformation in general had growing importance. But the resources of public administration in Austria are limited. For this reason a contract of support was signed between the Federal Ministry of Defence and the Ministry of Economy in 1986 which from that time on has been the basis of cooperation. Civil and military co-operation in Austria for production of geoinformation by means of this contract, will be demonstrated.



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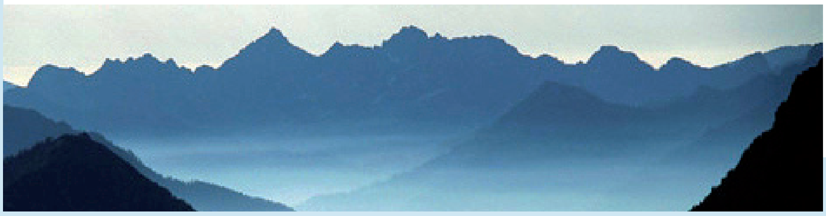

Military Geography and Un-Governed Space

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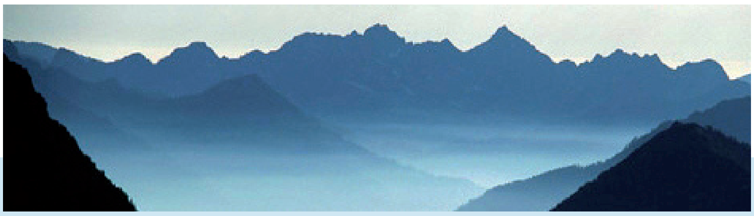
Poster presentation

South Waziristan is a mountainous region of northwest Pakistan, bordering Afghanistan. It has become perhaps one of the most important regions in the world in the context of the Global War on Terror. Although a part of Pakistan's sovereign territory, the region is not effectively controlled by the government and is a classic example of un-governed space and manifests the fundamental problems these regions pose to global security once they are exploited by terrorist organizations.

The situation in this rebellious tribal region has deteriorated since the 2001 U.S.-led invasion of Afghanistan. Portions of South Waziristan have essentially been turned over to Taliban control, without a fight from the Pakistani military, and tribal leaders in South Waziristan have invited the Taliban to establish control and effectively take over administration, law, and order in the region.

Un-governed spaces such as South Waziristan merit attention and careful study because although Western leaders may be able to remedy the problems presented by such an un-governed space through peaceful means using established diplomatic and international protocols, well-established diplomatic protocols and international doctrines and the principles they engender must be considered in light of the new global circumstance specifically the serious threat posed by a non-state actor with the avowed goal of fostering terror and perhaps promoting mass murder. Thus, government leaders may be faced with the very real specter of having to employ military force to subdue a transnational actor operating within an un-governed space of a sovereign state, perhaps even that of an "ally."

This paper examines the military geography of South Waziristan and the implications of effective sovereignty doctrine as it pertains to the potential employment of external (i.e., Western) military force to stabilize the situation and reduce the terrorist threat.



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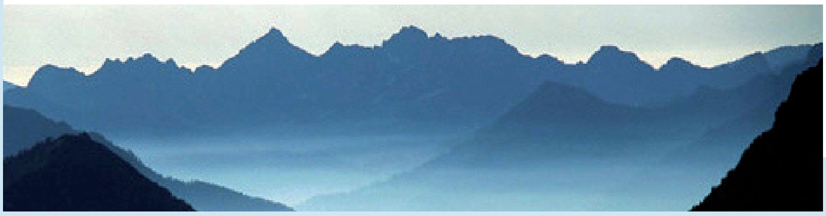

Climate Change Models and Outcomes from an Environmental Security Perspective

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Oral presentation

Climate data indicate that contemporary environmental change trends will continue. This is significant because many conflicts are enabled by environmentally triggered instability, latent ethic divisions, and exacerbated by population pressure and non-sustainable practices. Contemporary global climate change thus far has been gradual and the environmental security effects of global warming have been manageable.

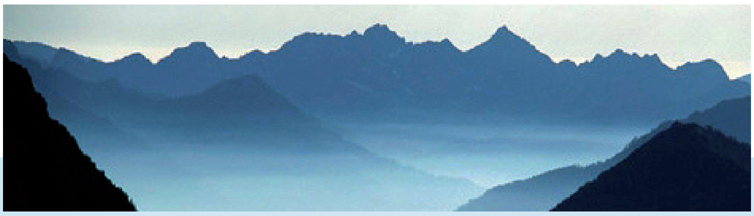
However, the climate and historical records indicate that abrupt climate changes have occurred repeatedly in the past and are linked to violent conflict. Certainly, future abrupt changes are possible given existing climate models, and anthropogenic influences may increase the probability of abrupt climate events.

The economic, ecological, and security impacts of such events could be significant, potentially serious, and exceed the management capacity of most states.

Rapid environmental change, exacerbated by extant non-sustainable practices could potentially destabilize the geo-political environment leading to violent intra and interstate conflict, and possibly a major global war.

Complex, interacting factors enable violent conflict, however, Military Geography offers an especially valuable vantage point from which to conduct an analysis of conflict and environmental security.

Ethnic warfare, like other violent conflicts, has profound roots in long-standing distrust, politically-charged manipulation, and weak governance; but, history has demonstrated clearly that economic disparity and environmental stress are certainly enabling factors. This paper will examine abrupt climate change models and outcomes from an environmental security perspective, and develop a regional framework to demonstrate the spatial pattern of potential threats and conflict zones.



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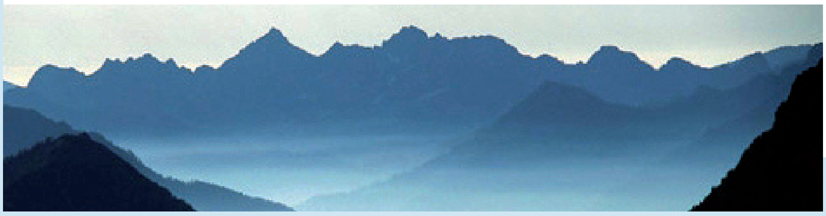

The Caucasus Region: A Military Geoscience Overview

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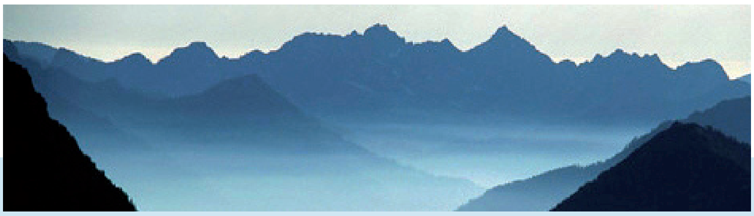
Oral presentation

The fighting between Russia and the Republic of Georgia in the summer of 2008 focused world attention on the Caucasus region.

This area has many geographic and geologic factors that play either a direct or indirect role in precipitating conflict. While the geology of the region has bestowed upon it large hydrocarbon reserves, control of these resources and the Baku-Tbilisi-Ceylon oil pipeline are causes of tension. Geographic fragmentation and the existence of ethnic enclaves have been the sources of armed conflict as well. The Caucasus region is a tectonic boundary between the Arabian and Eurasian plates; leading to a significant risk of earthquakes which may require military units to provide humanitarian assistance.

Given these factors, any future military operations in the region will be impacted by the mountainous terrain and its underlying geology. An understanding of the challenges posed by the geography and geology of the Caucasus region is crucial to the conduct of any military operation.



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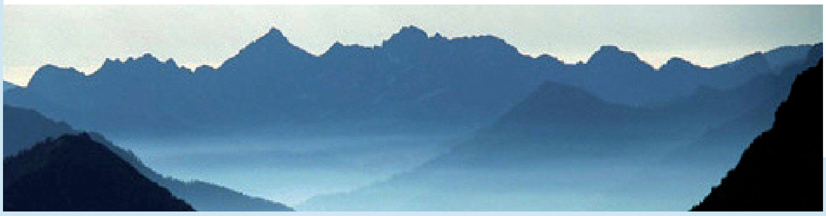

Military Terrain Analysis Using Google Earth

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Oral presentation

Keyhole Markup Language (KML) offers capabilities to combine text, graphics, and time animations tied to a map display. While KML lacks the full power of geographical information systems (GIS), viewers like Google Earth provide significant capabilities with a simple user interface. Databases created in a GIS program harness the full power of the GIS, with results exported in KML.

A KML file can interactively present analyses of military geography, with multiple ways of selecting and categorizing the display. KML allows turning layers on and off, and we can create layers based on chronological history, a single unit, or a particular operational aspect such as engineer support.

The same information can occur in multiple layers, allowing users to easily find aspects of interest. We can digitize and register historic maps and incorporate them into the KML file, create standard unit icons, and overlay viewsheds. KML makes it easy to prepare multi-media analysis keyed to geographic locations, while retaining a GIS focus that allows us to modify the display or add different base maps.

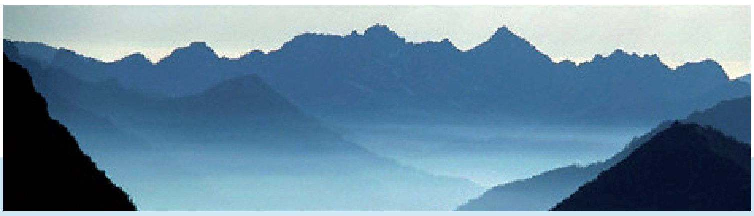
We will present examples from the War of 1812 (US versus UK), the American Civil War, the Indian Wars, World War II, and the battle for Dien Bien Phu.

For the battle of Antietam, maps show positions of each regiment at approximately hourly intervals, allowing us to digitize and animate their motions.

Users can select a portion of the map, and overlays such as slope or land cover.

For the western front during World War II, daily situation maps from Twelfth Army Group allow us to digitize the location of every division and the position of the front lines, and trace those in relation to terrain features and time.

These examples show the power of KML and simple viewers to explore the geographic component of military history.



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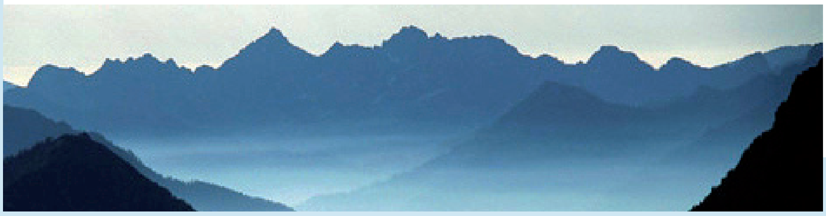

Photographic Mapping: The British Amateur Tradition

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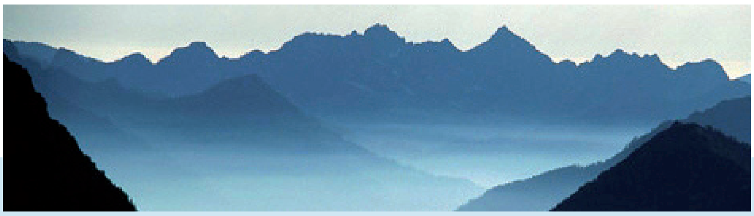
Oral presentation

This paper will consider how British aerial photography prospered in an atypical British ‘amateur’ fashion in the 1930s. Practitioners, who came mainly from the British upper class, were able to use their social position to develop photogrammetry and interpretation outside of official military channels, using all the available technologies primarily from Germany and Switzerland.

The paper will use the career of the Oxford educated climber/surveyor/geographer and finally photographic interpreter Michael Spender (latterly Squadron Leader Royal Air Force (RAF.)) Spender, an engineer, brother of the poet Stephen and photographer Humphrey, learnt photographic surveying in Zurich and Berlin, whilst climbing the Alps. He was then asked by the British Royal Geographic Society to help map and evaluation the terrain of Mount Everest as part of the 1935 Reconnaissance Exhibition.

Spender’s work on Everest was used in 1939 when Sidney Cotton (latterly acting Wing Commander RAF), an Australian pilot and photographic pioneer, took it on himself – with the help of MI6 - to undertake photographic reconnaissance of German installations prior to the start of hostilities in September 1939. Cotton bypassed the tired institutions of the RAF and formed his own reconnaissance unit both within and outwith the air force. He then called on Spender’s skills and knowledge to map and then interpret these images and those that Cotton’s pilots provided in the first year of the conflict.

The paper will then conclude with a case study of Spender’s work and a discussion of the role of the ‘amateur’ in the development of British photogrammetry prior to 1940. These ‘amateurs’ eclectic almost casual, but ultimately, successful adaptation of knowledge outside of both military and academic paradigms provide us with valuable lessons.



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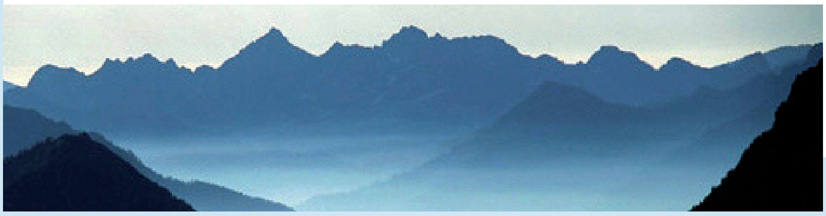

Characterizing Extreme Environments for Army Materiel and Human Performance Testing

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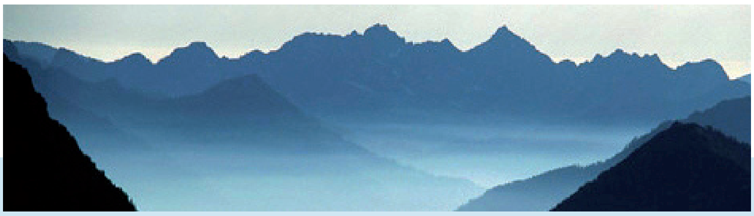
Oral presentation

History has taught the US Army the significance of military operations in extreme environments and current military doctrine requires that soldiers be trained and equipped to operate virtually anywhere in the world. This requirement challenges equipment, weapons, vehicles, personnel, and training programs. To prepare for the full spectrum of operations required of a 21st century military, the US Army develops materiel, equipment, and systems that are tested to ensure operational functionality and soldier performance under all environmental conditions. Further, US Army units conduct training in a realistic manner and in environments that simulate employment settings. Finally, the US Army must understand military operating environments worldwide, as well as collect and analyze the environmental data necessary to successfully plan for contingencies around the world. Extreme environments – the tropics, deserts, and cold regions – are those that present the most severe challenges to military operations, and knowing as much as possible about different extreme environments worldwide enables the US Army to better develop and test its equipment, train its soldiers, and plan operations.

Over the past decade, a series of expert panel studies have been undertaken to better understand extreme environments presently being used by the US Army for testing and training. After delimiting climatic, physical, and biological characteristics that define the ideal test environments for each extreme military operating environment and placing that setting within a comparative global framework, site-specific studies were undertaken to ascertain to what extent the variety of locations presently available to the US Army provide a suite of appropriate test-specific sites. This work is an example of locational analysis that demonstrates the integrative nature of geography and its utility for solving complex problems of military interest that typically cut across traditional academic disciplinary boundaries.



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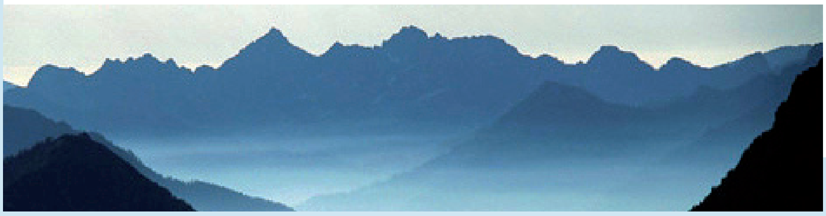

Towards a Definition of Military Geosciences

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Oral presentation

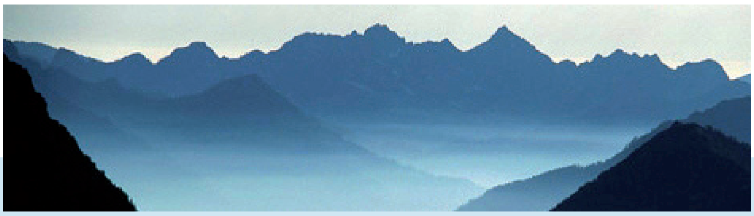
This contribution presents an overview on Earth sciences relevant to the military. Geosciences, applied geosciences and environmental geosciences but also other sciences, which not explicitly are called "geo"-sciences, such as atmospheric sciences (meteorology and climatology) or soil sciences (pedology, soil study) and others, support military operations on our planet Earth. A sound background in geosciences is useful for answering the question which science can be termed a "geoscience".

Presenting definitions for interdisciplinary sciences from literature and from the Internet encyclopaedia, we argue that many (if not all) primarily non geoscientific disciplines temporarily can turn to geo-disciplines, whenever their geo-aspects become relevant to geo-oriented decisions.

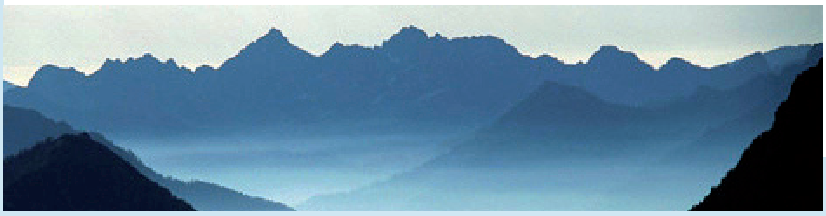
"Military Geography" is the traditional term for the military organisation providing geospatial support to the military command. It is still under academic discussion, however, if geography can be termed a geoscience, in particular when focussing on human and social aspects. Consequently, we pose the question if "military geography" as such can be termed a military geoscience. For this reason we propose the term "military geosciences" - a term, which seems to be very useful for encompassing complex geoscientific activities relevant to the military.

If military geosciences are abbreviated as "Milgeo", Milgeo can stay for military geosciences and for the organisation behind them. Milgeo provides information on geotactical, geo-strategic, geo-operational and geo-political decisions. Milgeo serves military commands as well as civil-military actions. And in countries with a militia army such as Austria, geoscientists of the militia system strongly support Milgeo.

This paper aims at defining the scope of military geosciences to offer a basis for further discussions on what kind of civil geoinformation is available for military deci-



sion-makers. The purpose of this paper is to enhance military geosciences and to strengthen the military geoscientific community.



200 Years of German Military Geology (1799 – 1999)

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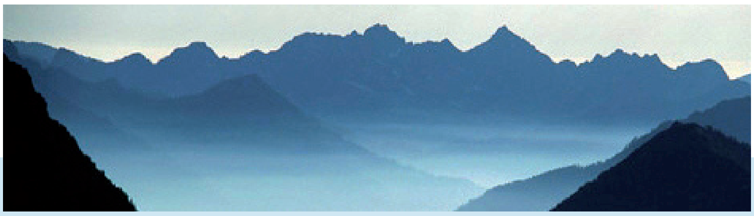
Poster presentation

The German officer Johann Samuel von Gruner (1766-1824), who was born in Switzerland, can be termed the founder of military geology in Europe. When serving in the Swiss army in 1799, he experienced the important influence of subsoil geology on military actions. About 100 years later the German engineer officer Walter Kranz (1873-1953) published the first paper explicitly dedicated to military geology. Being aware of the importance of geology for military planning, in particular for underground construction, mining and water supply, Walter Kranz started a second career and received his PhD in geology at the Ludwig Maximilian University of Munich. Major Dr. Walter Kranz set a milestone in German military geology, matching applied geology with military needs.

During the First World War the allied German and Austro-Hungarian armies made use of about 260 military geologists. Between the First and the Second World War several textbooks were published on military geology, at that time termed defence geology („Wehrgeologie“) in Germany. During the Second World War about 350 military geologists in total worked for the Deutsche Wehrmacht and in particular for the army, the air force, the navy and the Waffen-SS.

After the Second World War, the period of the so called “Cold War” faced the Western European countries with invasion plans of the former “Warsaw Pact” countries. The concept of nuclear balance enforced civil protection in the larger cities, and military geologic terrain analysis in the frontier regions of the former Federal Republic of Germany and also of Austria. After the fall of the “Berlin wall” and the disintegration of the “Warsaw Pact” armies in 1999 the military scenarios have changed in Europe. New challenges have come up, such as the military geologic support of worldwide operations for peace enforcing, peace making, peace keeping and humanitarian assistance.



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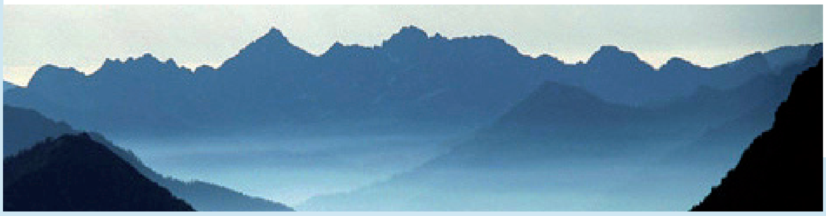

The "Forschungsstaffel z.b.V.", a Special Geoscientific Unit of the German Counter Military Intelligence Service During the Second World War

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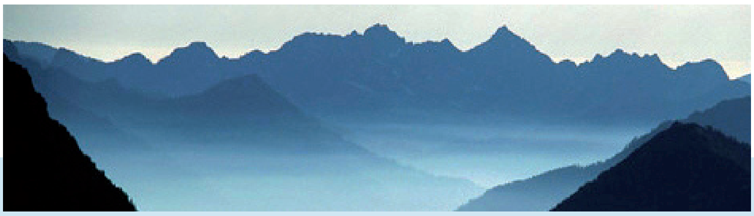
Poster presentation

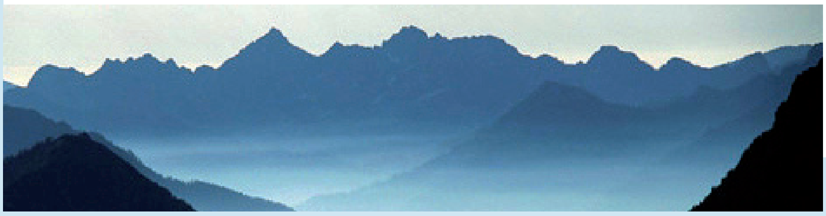
In January 1941, the German Counter Intelligence Service of the Armed Forces High Command ("Oberkommando des Heeres", OKH) launched the operation "Theodora" to update maps of Northern Africa for the German warfare and to reconnoiter the frontier between Libya and Chad. A special detachment was sent to Libya in April 1942, termed "Sonderkommando Dora". Special command "Dora" consisted of a combat unit of about hundred soldiers and a scientific team of about ten military geoscientists, such as geographers, geologists, astronomers and road specialists. The military scientific teams were fully motorized and supported by airplanes for reconnaissance flights. Head of this staff was the geographer Dr. Otto Schulz-Kampfhenkel, reserve lieutenant of the German Air Force.

From April 1943 the (former African) research group now was termed "Forschungsstaffel z.b.V" which was short for "zur besonderen Verwendung" meaning for special use of high military commands. From that time the Forschungsstaffel became an increasing unit for geoscientific support of German troops in the European theatres of war. It received the identity of a company consisting of in total 100-150 personnel of both geoscientists and technicians. Military orders were probably more placed by the Empire Research Council ("Reichsforschungsrat") than by the German Counter Intelligence Service of the Armed Forces High Command.

The unique core competence in military geosciences of the Forschungsstaffel z.b.V. lay in the integration of information from all literature and maps available at different institutions, and local field studies supplied by reconnaissance flights. Depending on the military demand, the military geoscientific teams consisted of geographers, cartographers, geologists, soil scientists, vegetation scientists, meteorologists, astronomers, hydrologists, and road engineers. In addition, universities and governmental offices supported the Forschungsstaffel z.b.V. as well. The



results of these integrated surveys were printed as special maps of the Forschungsstaffel z.b.V. at different scales, as e.g. river maps 1 : 25.000, tank maps at scales varying from 1 : 50.000 to 1 : 200.000, special maps for air landing zones 1 : 200.000, and others. These maps definitely were not classified landscape maps, but served as a basis for assessing the landscape depending on the military demand.



The International Handbook on Military Geography – A Benchmark of Military Geosciences

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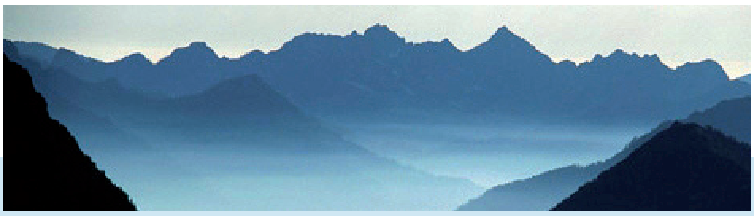
Poster presentation

Military application of geosciences in war and peace traditionally is provided by an organisation termed "Military Geography" or "Milgeo". This office makes use of the knowledge from experts in cartography, geodesy, geography, geology, geophysics and in other geo-related sciences for the armed forces. Referring to the definition of John M. Collins (1998) "military geography" concentrates on the influence of physical and cultural environments over political-military policies, plans, programs, and combat/support operations of all types in global, regional, and local contexts. In their recent paper on the "Theory of Military Geography" Reinhard Mang and Hermann Häusler (2006) tried to simplify the geospace by "geomodels" as a prerequisite for geospace-oriented decision-making.

When geo-informatics became a new discipline, and high-resolution satellite images were widely used, the use of classic cartographic hard-copy products, as provided by military cartographers, decreased. Accordingly, the former NATO "Military Geography Conferences" then turned to NATO Partnership for Peace (PfP) "Geospatial Conferences". As a result of a civil-military cooperation project the Military Geographic Service of the Austrian Armed Forces and the University of Vienna presented the first "International Handbook Military Geography" at the NATO & Partnership for Peace "Geospatial Conference" in Brussels in 2006.

The "International Handbook Military Geography" consists of 52 papers presented by authors of seven different European countries. Its articles are divided into three thematic blocks, namely "Basics and Tools", "Tasks and Applications", and "Perspectives and Horizons". This handbook has been ordered by military academies worldwide and therefore has become a benchmark in military geosciences.



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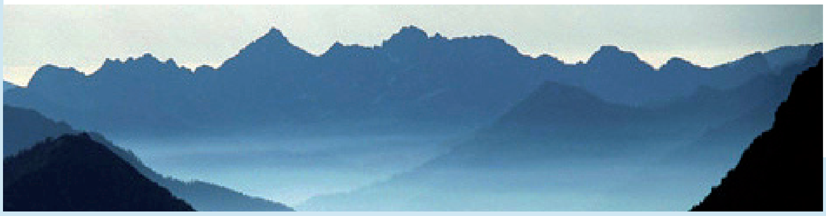

Report on Seven National and International Conferences on Military Geology and Military Geography, held from 1994 -2007

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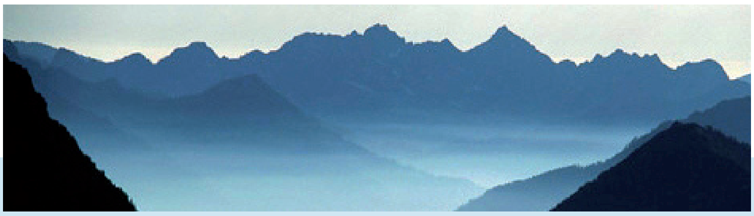
Poster presentation

Up to now seven public conferences on military geology and military geography respectively have been held in the United States of America, in Great Britain and in Canada. The first two conferences contributed to military geology, namely in Seattle (USA) 1994 and Warwick (UK) 1996. Since 2003 case studies in military geography and military geology were jointly presented at West Point (USA) and at Nottingham (UK). The sixth conference held in Nottingham in 2005 and the seventh conference held in Québec 2007 officially addressed an international military geoscientific community. Regarding the titles of the conferences, of the proceedings and of the contributions, military geology and military geography obviously played and play an important role in military operations.

This report on the seven conferences intends to characterize geospatial factors of military operations as can be derived from the published contributions. Each of the seven conferences is briefly described, their overall theme, and topics of the daily sessions. More detail is given on the 1996 Warwick conference and on the 2007 Québec conference, which were joined by the author.

A change of paradigm is visible in European countries when NATO "Military Geography" Conferences turned to "Geospatial" Conferences and since the "Geographical Section" of the Joint Force Command Headquarter at Brunssum (The Netherlands) turned into "Geospatial Section" in 2004.



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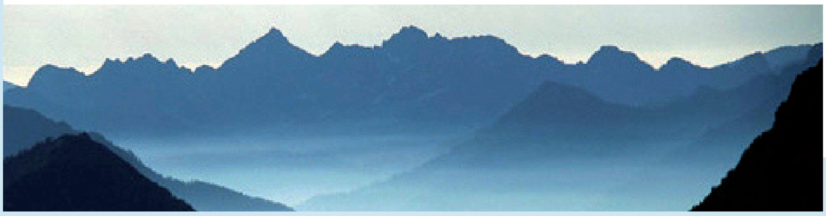

Differing Terms for "Military Geology" in German Speaking Countries

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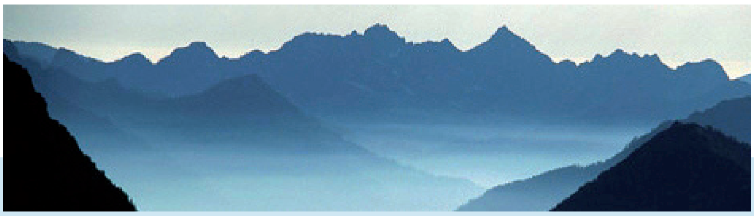
Poster presentation

Military geosciences can be defined as applied geosciences for military purposes such as military geography, military cartography, military geodesy, military geophysics, and military geology. In many languages the terms "military geology" as well as "war geology" are known for the application of surface and subsurface geology for military use during peace and wartime.

In Austria and Germany, however, in addition to "Militärgeologie" for military geology and "Kriegsgeologie" for war geology also the term "Wehrgeologie" is used meaning "defence geology". In order to set up a basis for a special international dictionary of military geosciences we describe the German meaning of defence geology as an example of defence sciences or defence technology, in German language known as "Wehrwissenschaften".

To our knowledge the term "Wehrgeologie" first was widely used in Germany between the First and Second World War. In 1938 two textbooks were published, the one on "Wehrgeologie" and the other on "Technische Wehrgeologie" (= technical defence geology) which still are fundamental for the knowledge on military geology in German speaking countries.

Whereas the term "Technische Wehrgeologie" has not been used in Germany any more after the end of the Second World War, the term "Wehrgeologie" still is in use for personnel of the German armed forces and therefore German military geologists are called "Wehrgeologen". This is not the case in Austria where civil geologists serve as military geologists in the militia system. The term "Wehrgeologie" is not used within the Austrian army, but since 1984 a working group for defence geology is affiliated to the Austrian Geological Society ("Arbeitsgruppe Wehrgeologie" der Österreichischen Geologischen Gesellschaft).



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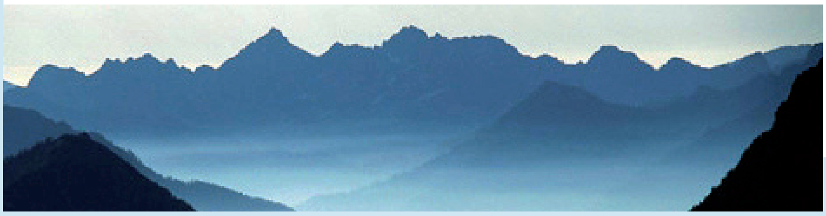

Why International Conference on Military Geosciences?

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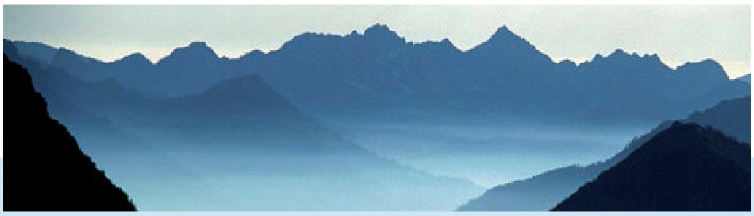
Poster presentation

The 21st century faces new challenges such as the global climate change and its socioeconomic consequences. New security policies and the transformation of armed forces also imply changes in the need of "geo-information", traditionally provided by an army organisation called "Military Geography".

The contribution of traditional pure and applied geosciences such as geography, geology and other "geo-disciplines" has diminished and the use of methods of other (primarily non geo-) sciences, such as computer sciences has increased. When informatics provides layers of "geo-data" it is termed "geo-informatics" and "Remote Sensing" as a computer science portrays the environment of our "geospace" by channels of the electromagnetic spectrum.

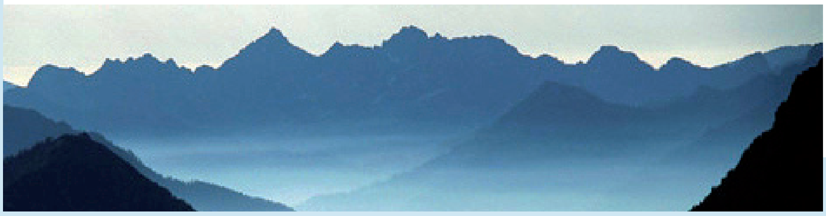
Geosciences still can be defined as natural sciences, but applied geosciences and environmental geosciences nowadays bridge the gap between human sciences and environmental sciences which originally was the claim of traditional geography integrating physical geo-graphy, human geography and social geography. Since the term "landscape" ("Landschaft") in geography is obsolete, "landscape ecology" has become a new discipline. If geosciences have to be defined in a new approach, consequently also military geosciences will need to be revised. For these reasons it is useful to discuss what we understand under military geography, military cartography, military geodesy, military geology, military geophysics and other sciences applied to the military. As a consequence, also NATO turned its organisation traditionally termed "Military Geo-graphy" to "Geospatial Intelligence" or "Geoinformation".

The human-environment-interaction is recognised as a complex system for "geotactical"-, "geo-operational"- and "geo-strategic" planning. Therefore it is necessary to precise scope, methods and core competences of military geoscientists. The 2009 Vienna "International Conference on Military Geosciences" aims to act as a platform for com-



munication and knowledge exchange and to create a network between applied environmental geosciences and the military.

Military geosciences can be defined as applied geosciences for military purposes in a wider sense and should contribute to a better understanding of both geoscientific capabilities and military needs.



Harpers Ferry (West Virginia) – The Impact of Geology and Mountainous Topography on Military Operations During the American Civil War

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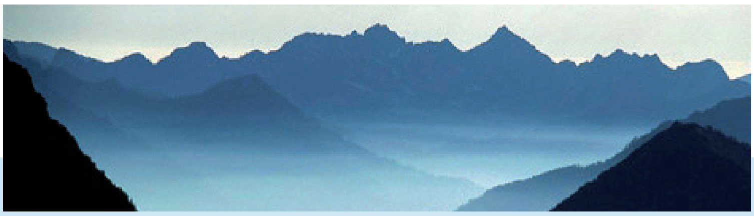
Oral presentation

Harpers Ferry, West Virginia lies at the boundary between the Blue Ridge and the Valley and Ridge Provinces of the Appalachian Mountains. It developed as a hydro-powered industrial community in the water gap at the confluence of the Potomac and Shenandoah Rivers. The site was chosen for one of two United States Armories and Arsenals in 1795; construction began in 1799. It became a major transportation hub when the Chesapeake & Ohio Canal and the Baltimore & Ohio Railroad where built in the 1830s.

A fining upward sequence of Lower Cambrian metasediments, which were folded as part of the Blue Ridge-South Mountain anticlinorium, has undergone differential erosion. The resultant mountainous terrain figured prominently in the Civil War. Although well suited for the development of hydro-power, the town frequently flooded and was found to be indefensible from attack. During the Civil War Harpers Ferry changed hands eight times.

The most significant attack took place during Lee's September 1862 campaign to invade the north when the Union garrison at Harpers Ferry would have been in the rear of the advancing Confederate forces. As such, Lee divided his army and sent a portion to capture Harpers Ferry. General Thomas J. "Stonewall" Jackson used the topography to his advantage. Jackson waited while Confederate forces occupied Maryland Heights and Loudoun Heights. These two ridges, which constitute the water gap, are both underlain by resistant Weverton Formation quartzite. Surrounded by Confederate artillery on the high ground, the Union garrison surrendered on September 15th 1862, resulting in the largest capture of Union troops during the Civil War.



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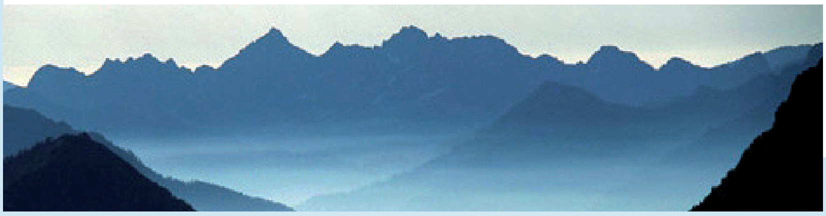

R. SCHWINNER's substantial contribution to the mitigation of avalanche threat in the Southern Alps. – An Austrian example of Military Geology during "World War I"

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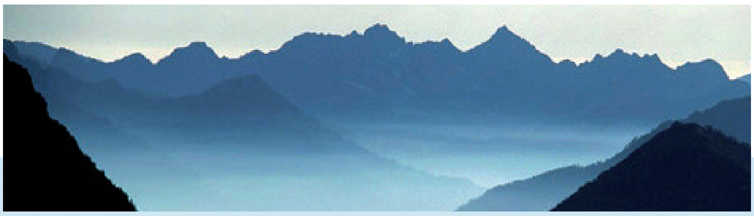
Oral presentation

The dual (scientific & military) career of the Austrian geologist Robert SCHWINNER (1878-1953) started in 1896: after leaving the Melk Abbbey Grammar School he served as a one year's volunteer with the Railroad & Signal Regiment in Korneuburg to become a reserve officer of the Austro-Hungarian Army (rank of a second lieutenant achieved in 1900).

His academic education started with studies in engineering at the university of technology in Vienna, continued by studies in various fields of natural sciences at the universities of Jena, Munich and finally Zurich. His Ph. D. – thesis, subject to the investigation of mass movements (topic: The Monte Spinale near Campilio and other rock falls in the Southern Alps), was elaborated under supervision of A. HEIM in Zurich and successfully terminated in 1911; after further studies at the university of Graz, he achieved the nostrification of his Ph. D. in 1914.

Due to his leisure interests SCHWINNER acquired good skills in mountain climbing and alpine skiing. Besides that he got well experienced in taking photographs of landscape using a plate camera of his own.

During World War I, both his academic as well as his leisure skills had implications on the military service of SCHWINNER. In 1915, when becoming the commander of a military position in the Austrian – Italian boundary region in the Southern Alps, he took photo shots of snow avalanche-prone slopes and used the photo prints to delineate with a pen safe movement-lines for troops as well as safe locations for stock piles of military supplies. Besides that SCHWINNER elaborated a military geologic map of an area in the Southern Alps that was published in 1917.



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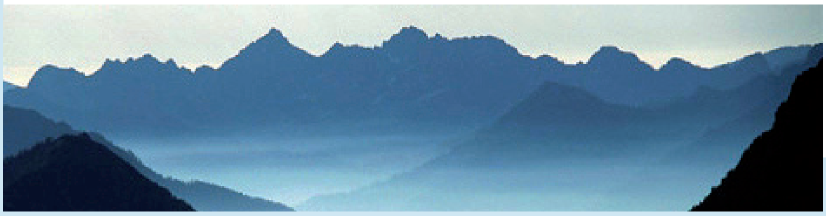

Historical GIS of the Normandy Invasion (Operation Overlord)

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Oral presentation

Integration of a wide range of historical data within a geographical information system (GIS) shows the spatial aspects of the Normandy invasion and enhances understanding of its many components.

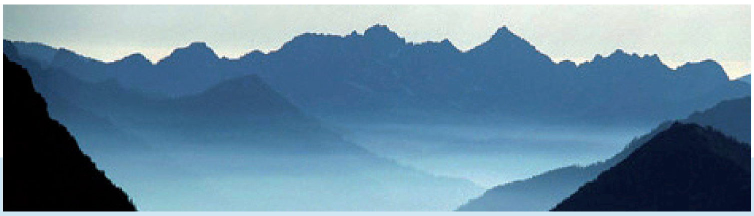
Operation Overlord was the largest combined arms operation in modern military history, involving air, land, and ground forces from a large international coalition, and understanding its history still has implications for current military operations.

Our GIS focuses on the first three weeks of the campaign, from June 6 to June 25, 1944. We have registered the daily situations maps of the 12th Army Group, from which we have digitized the locations of each division and the front lines, which can be animated in a simple viewer like Google Earth.

The database includes contemporary combat photography, art work, and large scale maps of the beach defenses. In addition, we have multi-beam bathymetry and side scan sonar imagery of the archaeological survey work done offshore, allowing us to show the losses of naval vessels during the operation.

We have built our analysis around the Mulberry harbors, showing their emplacement and the ranges of German artillery, and the availability of alternative ports when the decision was made not to replace the American Mulberry at Omaha Beach when storms destroyed it in mid June.

While we conducted our analysis in a traditional freeware GIS, we have displayed it in Google Earth which allows us to integrate maps, photographs, and texts, and allows users to interact with the data at different scales and by highlighting different aspects of the invasion.



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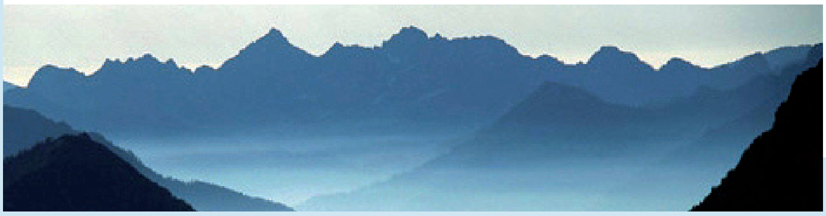

Terrain Evaluation Elicited From The Ancient Literature: Ground Truthing Of The Hannibalic Alpine Invasion Route Using Modern Geoscientific Methods

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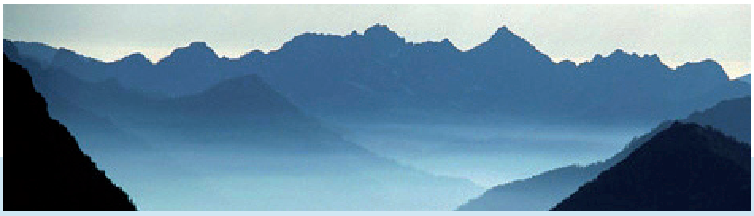
Oral Presentation

The ancient texts of Polybius and Livy, which detail the Punic Invasion of Italia in 218 BC, have been almost completely overlooked by military analysts for terrain/environmental information, much to the detriment of the historical summaries published over the last two millennia. Eliciting environmental information from the ancient texts has recently prompted four expeditions to survey the approach routes through the Pyrénées and the Alps, a research effort that led to the identification of sites of interest to historical archaeologists. All previous attempts to identify the alpine invasion route, and ultimate col of passage by the Hannibalic Army into Italia, relied on historical interpretation and precedent, time/motion analysis and preliminary topographic assessments.

The use of modern geoscientific methods in the analysis of key environmental parameters, elicited from the classics literature, is critical to identifying, not only the invasion route, but key areas where artifacts may be recovered.

These methods and exploratory recovery areas are summarized here following a brief description of the historic context and scientific techniques – geologic, geomorphologic, and chemical – used in this effort. Only one invasion route, out of a number proposed, matches the classical texts in form and content – the southern approach through the Combe de Queyras and over the Col de la Traversette into the Upper Po River, the vector first proposed by Sir Gavin de Beer over five decades ago.



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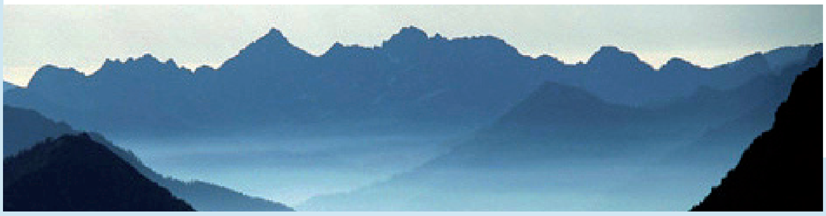

Information about Excursion - The Military Background

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Oral presentation

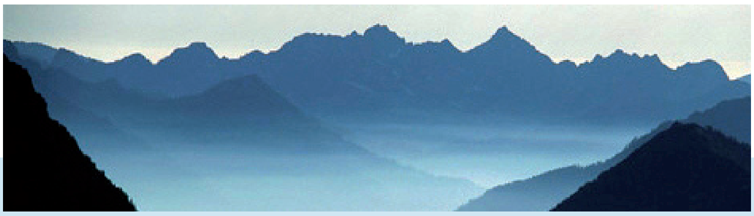
1. World War I in High Alpine Regions (Austro-Italian Border)

In May 1915, Italy declared war to the Austro-Hungarian Monarchy which was – at that time – heavily engaged in Serbia and Russia. The only chance to defend the high alpine borderlines against Italy was an extensive use of the terrain. By this, very few troups and personnel could make Italian planners believe that there was a considerable defense capacity on the Austro-Hungarian site. Artillery duels therefore were the means to fight each other during the first weeks of war. So the urgent need for keeping respective observation points on top of hills, mountains, needles, rocks etc. was evident. So it was not the terrain as such which was important to keep, but much more the observation points given by the terrain. Thus, an incredible small number of forces could defeat the Italians until reinforcement was available.

In a second stage, the two winter periods of 1915/1916 and 1916/1917 were characterized by more casualties by climatic conditions (temperature, snow, avalanches, etc.) than by original military activites. A lot of improvisations helped the soldiers to survive (caves, fortresses, real cities under glaciers, cableways, etc.). Transportation of everything from the valleys to the outmost points was a permanent key problem to survive.

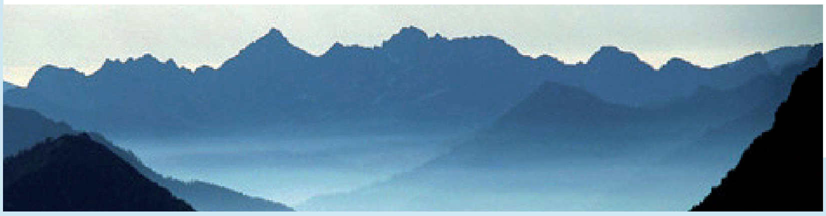
2. World War II in Alpine Regions (Semmering Area) and The Fall of the Iron Curtain in 1989

In early 1945, the Eastern front in central Europe approached the south eastern part of the Alps. The Deutsche Wehrmacht was nearly beaten and could only try to make an ordinary withdraw towards the so called “Alpenfestung”, which never existed. Primary goal was to enable as much soldiers as possible to move over the Enns River, the planned demarcation line between Soviet and Angloamerican forces. The Semmering Area was a natural door to the Styrian industry zone along the Mur and Mürz Rivers and this door was to be closed as long as possible. Clever



military planning, the use of specialized high mountain artillery and a very strong terrain enabled German Forces to defend the area, even to reject some Soviet attacks until the first day of May, 1945. Even today, remnants of this period can be found in the area.

Not far away, in the open area of the Austro-Hungarian border, another world historic event happened in 1989. Near the borderline, in the Sopron area in Hungary, there was a "Paneuropa meeting". During this meeting, the Iron Courtain was opened by the Hungarians and a great number of people used the opportunity to flee from Hungary to the west – 3 month before the fall of the Berlin Wall! So it is historically correct to call this point near the small village of St. Margareten the starting point of all later events in 1989, which completely changed the worldwide geopolitical situation of the following decades!



Theory of Military Geography

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Oral presentation

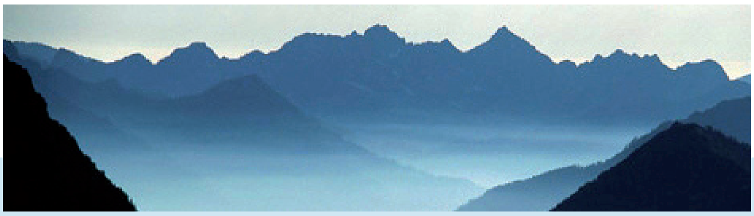
When talking about Military Geography and Military Geosciences, clear terminological definitions should be established. This can be done by investigating the theoretic basics of the area of activity concerned.

As the majority of all sciences in a very wide sense, military geography aims at creating models of a very complex reality in order to make this reality operable for human decision making. In case of military geography, this "complex reality" is the "geospace" with all its geographic and military objects and relations between these objects. The task is to select all those objects and relations from reality which are relevant for a specific decision making process. The number of selected objects and relations should be as small as possible to make these decisions as easy as possible, but still logically correct and reproducable. As this is often contradictory, complexity and usefulness have to be harmonized in an appropriate way, but this is the primary challenge of every science.

The product of modelling the geospace is a "mil-geo-model", a model consisting only of military and non-military (geographic) objects – now called "factors" (of a decision) and relations between them – now called "functions" (of a decision).

Whenever portraying only the factors (represented by their attributes) of a milgeomodel, it is up to the user to interprete and draw conclusions for his decision making.

Whenever additionally portraying the functions of a milgeomodel, decisions more or less can be calculated – always depending upon the quality of the milgeomodel itself. Extracting and operationalizing the functions of a milgeomodel can be defined as the primary task of "geointelligence". Geointelligence thus is nothing else than making milgeomodels completely transparent and applicable for reproducable military decision making.



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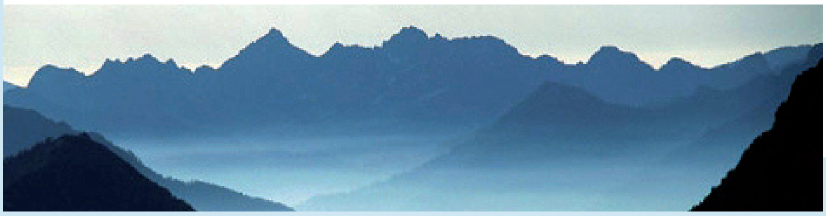
This presentation will show the theoretic background of military geography as well as some concrete examples of the use of milgeomodels for decision making.



War in Alpine Regions

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Oral presentation

This presentation will mainly apply to the High Alpine Mountains of central Europe, concerning special conditions for military operations, specific areas of interest dealing with World War I and II, lessons learned, etc.

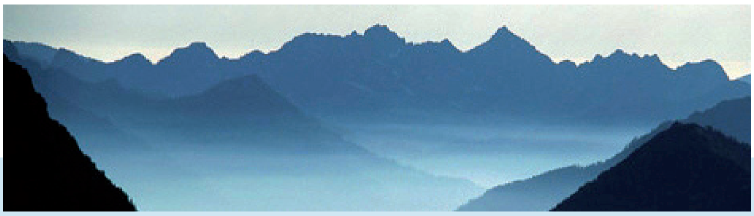
In the first part of this presentation, some terminological aspects have to be considered. What are "High Alpine Regions"? What about relatively low mountains such as those of northern Norway, on the Lofote Islands near sea level where you can find comparable conditions to the really high areas of the Alps in central Europe? What about distinguishing between specific criterias for infantry, cavallery, engineers, etc.?

In the second part of this presentation, special conditions and experiences from the two World Wars are investigated.

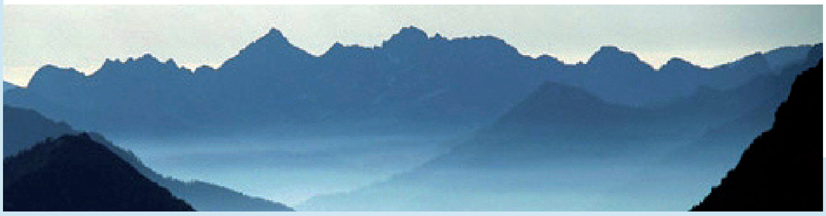
The World War I theatre of high Alpine War in Europe mainly concerned Austria-Hungary and Italy. It was predominantly a permanent battle for single positions, overlook points, approaches to pass regions, etc. A lot of transportation means was erected such as new railways in the valleys, supply roads from the stations to the battlegrounds and a great number of cableways to support the fighting troops.

World War II in contrast engaged much more mobile warfare, even in the high alpine regions. Planners made much effort to avoid any standstill of military actions in the theatre of war, keeping in mind the terrible static warfare of 1914 – 1918. The main areas of alpine warfare were more or less at the periphery of Europe such as in Scandinavia, in the Caucasus area, the Balkans, parts of the Appenin etc. Only at the end of the war, there were some considerations on the German side to continue the battle within the so called "Alpenfestung", which was never realised.

To sum up, conditions in high alpine warfare are quite different from all other theatres of war, but the impact of these conditions on military operations vary with the tech-



nical development, the resulting equipment, the tasks and the rules for any military engagement in such areas. Anyhow, we should keep in mind the well known slogan of the Institute of Military Geography of the Austrian Armed Forces - "Terra Semper Invicta" - the terrain has never been defeated!



The Nature-Military Alliance: Nature Conservation and Military Control on the Landscape in the Post-Cold War Era

Jean MARTIN

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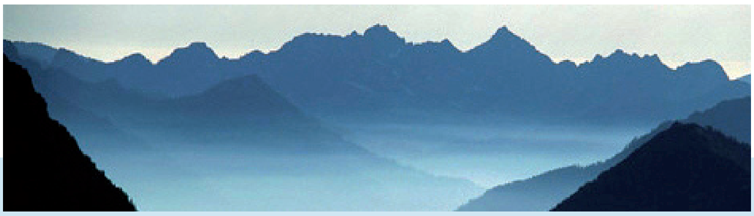
Oral presentation

Nature conservation movements and military authorities are inherently allied for the achievement of one great objective: to keep human beings off of large tracts of land. Coinciding with the closing of large military bases and training areas all across Europe and North America in the post-Cold War era, nature conservation movements grew in strength and started to claim control on those lands that were no longer required for military use. In many instances, military authorities will welcome such initiatives as they fundamentally prolong government control over those areas. This might be seen as a positive sign of environmental awareness on the part of the military, but it might also stem from an interest in having nature protection as a surrogate for the military until those areas are required again for training or base construction purposes. A survey will be presented of the situation in Canada, the United States and some European countries in order to determine whether certain patterns can be identified and major differences emerge in the way handover of military properties is handled in those places.



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The Changing Geography of Canadian Military Deployments, 1867-2009

Jean MARTIN

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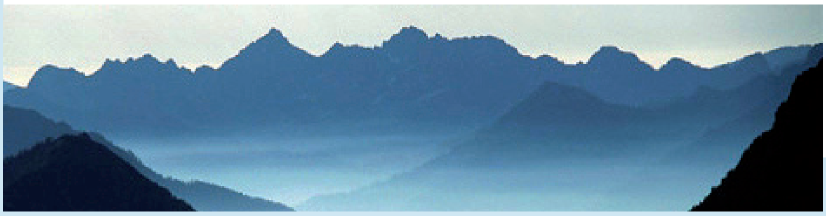
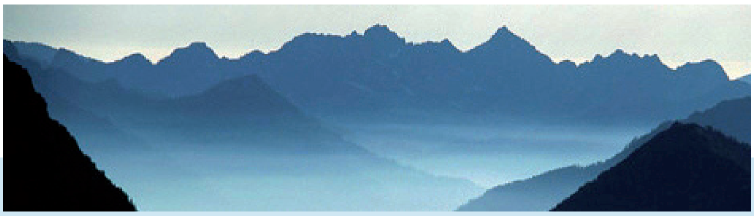
Oral presentation



The Canadian military evolved, since its beginnings shortly after the Confederation Act of 1867, within a colonial framework that can still be recognized today. The offspring of the British Army the Canadian Militia was used at an early date in support of colonial expeditions across the world, as would in turn be the Royal Canadian Navy, of course modeled on the Royal Navy, in the first decades of the 20th century. Yet the Canadian forces could not march along with Britain in all her enterprises and there were nonetheless certain Canadian motivations in the decision to send forces to certain parts of the world and not to others. Is there some geographical patterns those various deployments could reveal over the several decades of British dominion?

And how would those patterns be influenced by the shift of Canadian allegiance to the American neighbour that occurred in mid-20th century? And how did the self-acclaimed commitment to UN peacekeeping combined with the more massive yet somewhat less celebrated involvement in Cold War confrontations? Maps of Canadian forces deployments at different points in time will be presented and examined in connection with an analysis of the evolution of Canadian defence policies. However, not even once in its history has the Canadian government despatched forces beyond the national borders in an independent operation, so imperial and alliance politics will also have to be taken into consideration.



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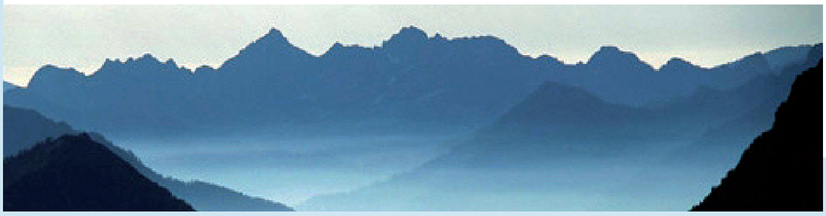

Integrated Desert Terrain Forecasting for Military Operations: Geologic Basis for Rapid Predictive Mapping of Soils and Terrain Features

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Oral presentation

Military history indicates that deserts are commonly strategic sites for military operations.

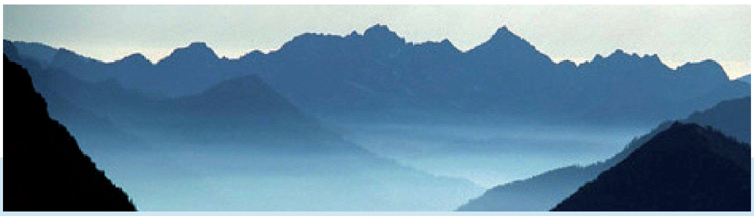
Successful mobility, flexibility, and rapid military deployment, however, require the ability to predict diverse conditions common to desert terrain.

At present, the U.S. military cannot rapidly and efficiently perform the terrain analysis that is required prior to deployment of personnel, vehicles, and weapons.

A fundamental reason for this is that desert landscapes are typically a complex mosaic of contrasting soil types and surface characteristics due to the juxtaposition of surficial deposits of variable age, lithologic and textural composition, and a wide range of landform morphologies. We are conducting a multi-year project to develop a GIS platform designed to provide a flexible, scalable, and adaptable model that predicts soil and terrain conditions in desert regions.

Two key geologic-based concepts provide the scientific basis for predictive mapping. First, comprehensive research regarding the formation of desert soils over the last 25 year demonstrates that systemic relationships exist between desert surficial processes and the location of soils across diverse desert landscapes ranging from dry lake beds to alluvial plains and valleys (common sites for military operations, testing, and training).

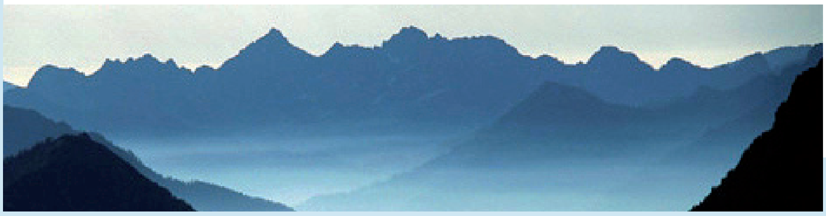
It is the knowledge of these systematic relationships that can be used to predict terrain conditions based on analysis of desert imagery. Moreover, new and emerging technologies that provide a wide range of environmental information to characterize surface conditions are being incorporated into the predictive model. Second, most common soil types can be readily linked with desert landforms that can be easily identified using available remote sensing imagery. This relation allows experts the ability to reasonably predict soil types using general knowledge of climate, landform age and type, and soil parent material



derived from properties that can be identified or surmised from imagery. Included in this research effort is the development of a global soil database that includes extensive information for soils common to desert regions of the U.S. southwest and SW Asia.

The geologic-based procedure can be easily adjusted to conduct mapping at strategic, operational, and tactical scales depending on information required for a specific military operation.

Once surface and subsurface conditions are estimated, the ability of vehicles to operate in specific locations can be assessed.



Modeling and Predicting Dust Emission Hazards for Military Rotorcraft in Deserts

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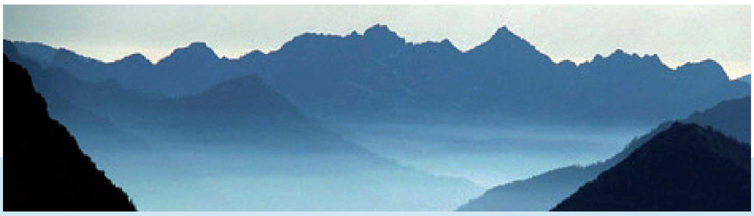
Poster presentation

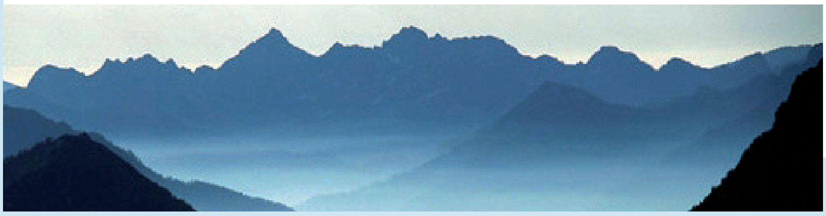
Brownout conditions, blinding dust clouds stirred up by the helicopter rotor downwash during near-ground flight, are recognized as the most significant of all military distresses when desert landings are necessary. Although the problem has existed since the 1970s, only recently have comprehensive efforts been devoted to combating brownout hazards. Most approaches involve either development of sensors to see through dust and predicting terrain conditions in landing zones prior to military operations.

We are developing a comprehensive geologic- and physics-based modeling system that can be used to both predict the location of dust hazards as well as model dust emission and transport and related impacts to visibility during military operations – information that can be used to better test and develop sensors to counteract brownout conditions.

The modeling system consists of five integrated modular components: (1) predictive soil maps; (2) background meteorology; (3) flow perturbation due to military operations (primarily rotorcraft); (4) dust transport and dispersion; and (5) visibility and brownout predictions. Soil predictive maps are based on geomorphic models to provide system (GIS) platform for predicting dust emission. Dust emission is simulated with a new version of the Dust Entrainment and Deposition Model (DEAD) model. Background meteorology encompassing processes from synoptic scale to mesoscale is predicted using a high-resolution Mesoscale Model 5 (MM5). Perturbations of the atmospheric flows due to rotorcraft operations are simulated using the Computational Fluid Dynamics model with an integrated rotor parameterization tool. Once the dust emissions and perturbed meteorology are known, a Lagrangian Random Particle Dispersion Model is used to accurately simulate the transport and dispersion of dust. We have developed an algorithm that uses the simulated dust



concentrations to predict visibility and brownout. Results indicate that the soil predictions and modeling will greatly enhance forecasting local and regional dust transport and dispersion as well as predicting brownout conditions for military operations.



Geo-Cultural Analysis Tool (GCAT): Socio-Cultural Understanding through Urban Population Bio-rhythmic Modeling

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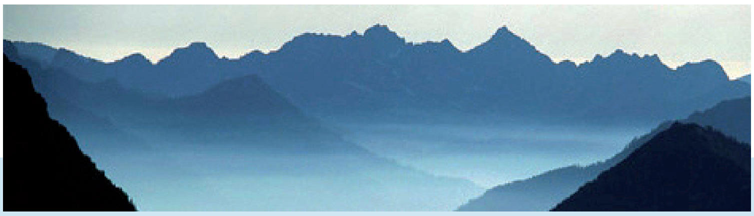
Oral presentation

Perhaps the biggest challenge to future operations is understanding the socio-cultural aspects of the urban environment and how they may impact on military missions. In a rapidly urbanizing world, military operations will increasingly occur in highly complex built-up environments densely occupied by local populations, the overwhelming majority of which are likely to be non-combatants. These non-combatants thus become dynamic physical aspects of the mission space that must be understood and accounted for as part of mission planning and the information preparation of the battlefield process. One method to accomplish this objective is through dynamic population behavioral modeling based on cultural and behavioral geographic principals.

To this end, research was conducted to create a system that models how local populations operate in time and space, how people move through and make use of the built environment in certain culturally proscribed ways. This requires understanding the cultural influence on how people interact with their built environment and using this knowledge to capture and model the rhythm and flow of daily life in an urban environment. This system, called the Geo-Cultural Analysis Tool (GCAT), models the cyclical routinized behavior of an urban population so as to forecast where people are likely to be located in the urban environment at any time of day and in what activities they are likely to be engaged. It does this by implementing a modified version of Torsten Hagerstrand's theory of time-geography called geo-cultural analysis.

The GCAT combines ontological modeling and geo-cultural knowledge libraries with time-geography to model the biorhythmic urban environment. This paper details the research and development of the GCAT and how it can help meet the future challenges of worldwide military operations.



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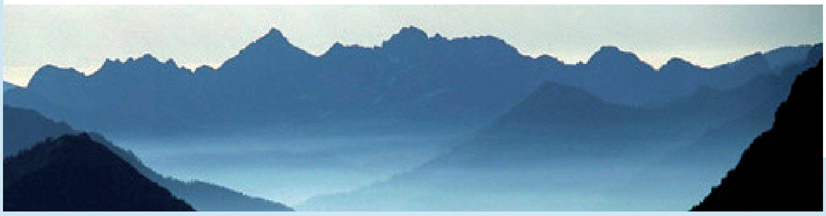

Global Climate Change and Potential Impacts on Future U.S. Military Operations

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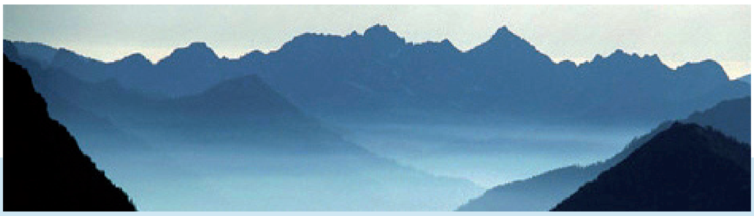
Oral presentation

Geographers are constantly reminded that changes to the ecumene can have profound social, political, and economic impacts on human inhabitants. Observed increases in global average air and ocean temperatures, widespread melting of ice and snow, and rising global average sea level provide unquestionable evidence of global climate change (IPCC, 2007). Many who postulate the effects on people and their ways of life around the world, anticipate that climate change may have a particularly negative impact on those regions of the world where people struggle to subsist on marginal lands. These are already volatile places as different culture groups compete for scarce resources.

Additionally, warming trends prompting the continual decrease in the extent of sea ice in the Arctic could create tensions among several countries who have sovereign claims or economic interests in the far north. When U.S. interests are at stake in such places, the U.S. government normally considers a range of diplomatic, informational, and economic options to effectively address the problem. When these measures fail, U.S. military forces may be employed to diffuse or resolve the situation.

Consequently, the U.S. Military must be postured to deploy anywhere in the world (to include regions where climate change contributes to deteriorating environmental conditions and escalating violence or threatens national interests) to undertake operations as directed by the U.S. government, the United Nations, or requested by allies or host nations. Although the individual service components (Army, Navy, Air Force) operate jointly during major operations and campaigns, each service would be impacted differently by climate change and rising sea level, given their differing missions, organization, and equipment.



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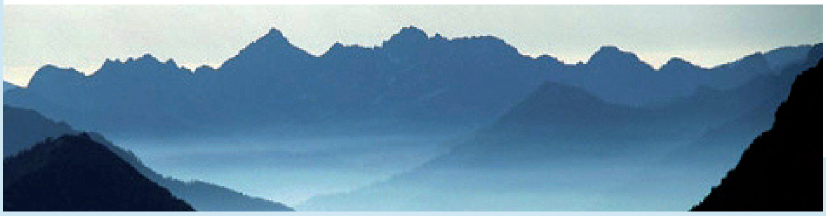

Mapping in the Peacekeeping Missions: the Case of UNDOF

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Poster presentation

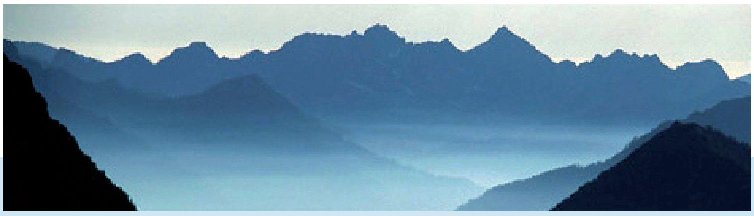
United Nations peacekeeping is a unique and dynamic instrument developed by the Organization as a way to help countries torn by conflict to create the conditions for lasting peace. There have been a total of 63 UN peacekeeping operations around the world. UN peacekeeping continues to evolve, conceptually and operationally, to meet new challenges and political realities.

The United Nations Disengagement Observer Force (UNDOF) was established by Security Council resolution 350 (1974) of 31 May 1974 to maintain the ceasefire between Israel and Syria, to supervise the disengagement of Israeli and Syrian forces, and to supervise the areas of separation and limitation, as provided in the Agreement on Disengagement.

In order to carry out its mandate, UNDOF maintains an Area of Separation (AOS), which is some 80 kilometers long and varies in width between approximately 10 kilometers in the centre to less than one kilometer in the extreme south (AOS is around 235 km^2). The terrain is hilly and is dominated in the north by Mount Hermon (2814m). The AOS is inhabited and is policed by the Syrian authorities. No military forces other than UNDOF are permitted within it. On both sides of the AOS follows the Area of Limitation (AOL) consisting of a 10, 20 and 25km arms limitation-zone.

The main role of the GIS unit in the peacekeeping missions is to support the mission in providing geospatial information, maps and GPS training. This includes analysis of terrain, developing geodatabase, developing website (GIS server), and Google earth. The GIS units in missions are also linked to the Headquarters in New-York and have the support of the Cartographic section (especially for start-up missions).

In the beginning of 2005 the mapping project at the Golan Heights started (thanks to the Cartographic section, UNHQ) to replace outdated operational paper maps that have been used by UNDOF battalions and UNTSO-OGG

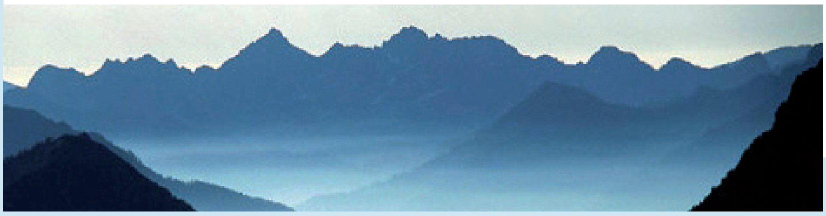


military observers for more than 30 years but no longer accurate on the ground, and to build geospatial capacity in the mission area,. A first step was to develop a digital database (VMAP 2 based on NATO standard) based on high satellite imagery (Quickbird and Ikonos). UNDOF collected over 150 Ground Control Points during winter 2005/06 and finally the database has been delivered. Fourteen topographic basic map sheets 1:50.000, based on the Universal Transversal Mercator System (UTM), have been developed. These fourteen map sheets cover the whole Area of Responsibility (AOR), which contains the AOS and the AOL.

As a first step the GIS unit UNDOF developed a briefing map – titled Overview Golan – containing the whole AOR. Especially for the needs of the peacekeepers other products like the AOS UNDOF, AOS AUSBATT, AOS POLBATT, Golan East and Golan West and Company (Coy) maps for each of the five line-companies were created. For the needs of OGG the GIS unit developed a Joint Area Familiarisation Training (JAFT) map catalogue, Observations Post (OP) maps (1:10.000) and Inspection maps during summer 2007. On average, 3.000 mapsheets per year have been printed. In 2009 Sector maps replace the former patrol maps. An Agreed farm cultivation map about farmers activities along the A-line, a Mine incident map (with all incidents since 1974), the 2nd edition of the JAFT maps (Nov. 2008), Car maps (A-side & B-side) for OGG and maps for protests against violations of positions within the arms limitation-zones are further products of the GIS unit.

Additionally the GIS unit has been involved with different training activities – such as GPS training for military personnel and Officers induction training. The unit is as well supporting the mission in fieldworks in the context of re-barreling projects and new agricultural projects along the A-line.

Thus the GIS unit UNDOF is fully integrated into the operations and the decision making of the mission.



Report on the Disaster Control Operation in Styria, as described by a Geologist of the Styrian Government

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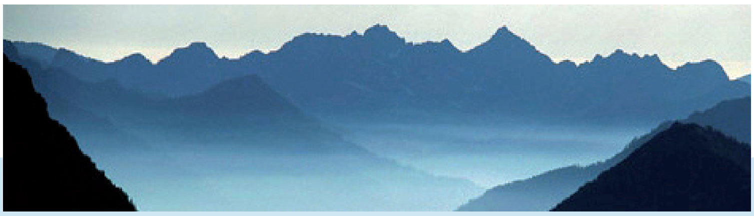
Oral presentation

Since 2003 there have been various disaster control operations in Styria caused by heavy storms, heavy precipitation and unfavourable geological conditions. Three of these disaster control operations are summarised as follows. In 2003 there was a rockslide in the high-alpine region of Veitsch. Two years later heavy rain showers caused a disaster with more than 600 landslides in the district of Weiz, in particular in the municipalities of Gasen and Haslau. In Spring 2008 the storms Paula and Emma caused vast destruction. All disaster control operations were performed by the Austrian armed forces in co-operation with a geologist of the Styrian government, supervised by the local mayor.

Each of the disaster control operation described needed a well-organised co-operation of all departments of the Styrian government, the Austrian armed forces (especially the military regional command of Styria), the fire brigades, the police and the alpine police, the "Bezirkshauptmänner" (district main commissioners) with their teams and the large number of local volunteers.



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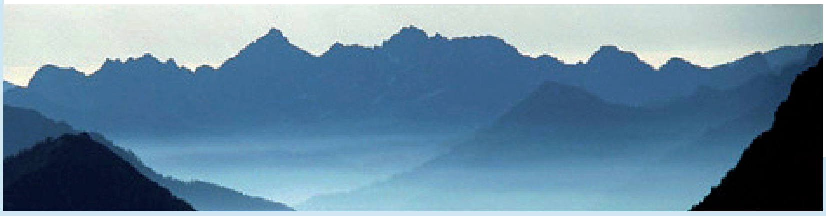

Trends of Strong Earthquake Activity and Military Disaster Relief

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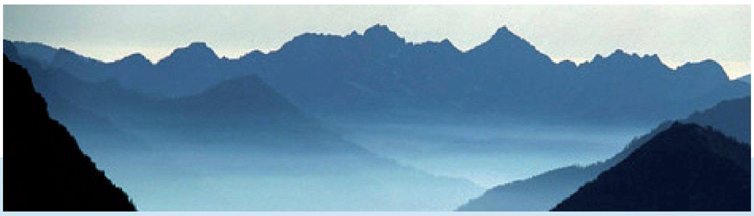
Poster presentation

The Austrian Forces Disaster Relief Unit (AFDRU) is a task force for international disaster response, e.g. for urban search and rescue (USAR) operations in cases of catastrophic earthquakes; the responsibility for the formation of the unit is taken by the NBC Defence School Lise Meitner (ABCAbwS).

In order to prepare for such missions and to perform it most efficiently, studies on strong earthquake activity for several target regions have been performed within the so-called MilwEx programme. This was done in a fruitful cooperation of the Fundamentals Division of the NBC Defence School Lise Meitner, Korneuburg, with the Department of Geophysics, Austrian Earthquake Service, of the Central Institute for Meteorology and Geodynamics (ZAMG) in Vienna.

In particular, the studies concentrate on the temporal performance of seismic activity of several major earthquake zones in southern Europe, Asia and USA. As already indicated in early publications in the past century, there exists a systematic seismic performance with respect to the time of the day as well as a seasonal cycle. The corresponding results obtained in the ABCAbwS – ZAMG cooperation turn out to be a very useful information regarding the preparedness of the AFDRU personnel for USAR and further relief operations.



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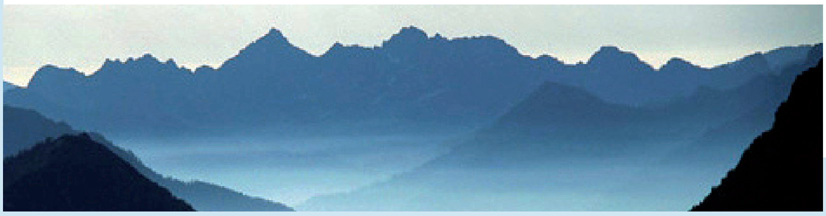

British field force geologists of World War II

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Oral presentation

Unlike the German Army, the British Army made use of very few geologists to serve as such during the 1939-45 World War.

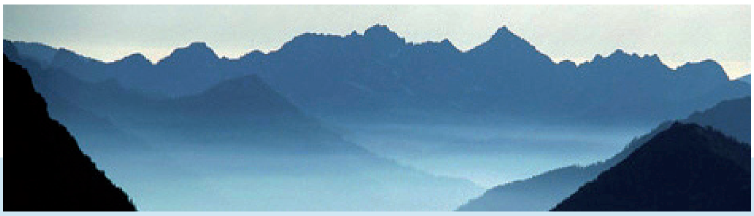
Major W.B.R. King deployed to France with the British Expeditionary Force in September 1939, serving as its geological adviser for water supply until the Force was evacuated via Dunkirk in May/June 1940.

Captain F.W. Shotton was sent to Egypt in May 1941, to provide geological advice to British troops operational in North Africa and the Middle East - guiding military well drilling for potable water and construction of temporary airfields, until final campaign victory in 1943.

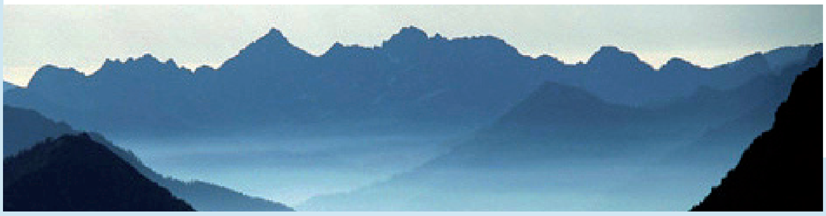
Captain (later Major) J.V. Stephens was sent to North Africa in June 1943, to accompany the Allied forces that invaded Sicily in July and mainland Italy in September, providing geological advice relating to military engineer 'intelligence' and 'works' until victory in 1945.

Even more significantly, Major (later Lieutenant-Colonel) W.B.R. King contributed geological advice until October 1943 to the headquarters planning for the Allied liberation of Normandy in June 1944, succeeded by Captain (later Major) F.W. Shotton for the final phases of planning and the subsequent operations in NW Europe until the end of the War. These few 'field force' geologists were supported and complemented by the resources of the Geological Survey of Great Britain throughout the War, but by small teams of uniformed geologists to compile terrain intelligence only from mid 1943 – the Strategic Branch of the Geological Survey of India (based in India, at Calcutta), created to support British operations in the Far East, and the Geological Section of the Inter-Service Topographical Department (based in England, at Oxford), founded to support Allied operations in Europe as well as the Far East.

Although each British field force geologist served as the only geologist in an Army or Army Group headquarters, most eventually needed and received some additional ge-



ological support. All of them were able to contribute in significant ways to military operational success, and together they set a precedent for the organization of present-day British military geology.



Influence of Geology on High Alpine Warfare during World War I

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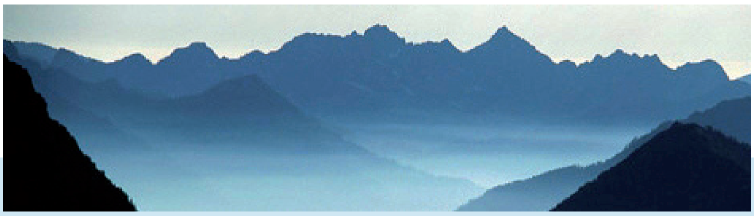
Oral presentation

Targeted application of geologic knowledge has contributed essentially to the success of military operations since the beginning of warfare. Trench construction and consolidation, mining-warfare as well as water-supply during World War I represent the first key-point in military geology's history. Austria-Hungarian, British, French, German, Italian and later American geologists advised their troops on subsurface activities and water-supply. For the first time both, Austrian-Hungarian and Italian Armies trained soldiers to fight battles under difficult conditions in high alpine terrain, where geologic aspects influenced tactics and logistics extremely.

The campaign in the high mountain ranges Ortler, Adamello/Presanella, Dolomites, Carnic and Julian Alps has been waged 1915-1917 as a static war. Engineer troops of the antagonistic armies constructed trails, excavated galleries and caverns in rock as well as in glaciers with the intent of fortifying own positions and blowing up their adversaries. From 1916 to 1918 thirty five blast off summits are recorded, which permanently reshaped some of the landscape, e.g. at the hard-fought peaks Cimone, Col di Lana and Sief, Lagazuoi, Pasubio. For instance, the summits and escarpments of Lagazuoi, west of Cortina d'Ampezzo have been excavated by branched systems of tunnels, emplacements and encampments. Galleries with diameters up to 2 meters were driven partly by hand, but mainly by means of pneumatic hammers, yielding 1 m per day. Due to the gently dipping bedded dolomitic rocks with close spaced joints, and negligible ingress of water rock support systems were dispensable. Those tunnels, used as supply service trails during wartimes, enable unhindered safe access at present time – almost 9 decades later.

Neither overmine nor overbreak is evident, documenting a good rock quality. Five mines were detonated, four of these Austrian targeting the ledge Cengia Martini and one Italian to gain a pre-summit of Lagazuoi. Preparing the



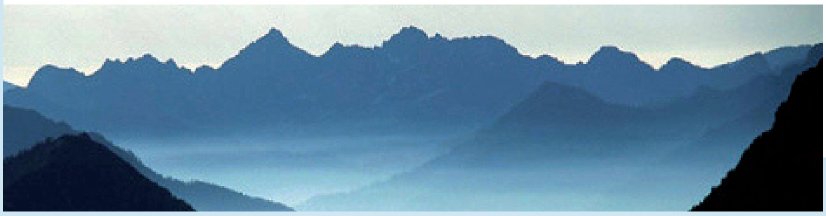
3rd Austrian mine explosion, 93 meters must be tunnelled including the explosion chamber. In May 1917 the charge of 24 tons explosives (Chlorate, Dynamon G, Dynamon M, Ekrasite, plus initiating charge) with 37 m tamping plug was detonated, targeting the rock jag Trincea Avanzata with exposed Italian emplacements. The scarp of displaced rock masses is about 200 m high and 136 m wide, 200,000 cubic metres of dolomite rocks have been released and disintegrated to gravel-sized debris, generating huge cones.

The Italian position was destroyed, indeed strategically insignificant. In the aftermath bit by bit another 30,000 cubic metres of crushed rock break down. During three years of WW I, both sides lost over 60,000 men in the Southern Alps (killed in action: company and battalion sized clashes, skirmishes between patrols at remote mountain tops), but another 60,000 would perish in natural disasters (rock falls, avalanches) and at least 60,000 more would freeze to death.

Die Menschen kommen und gehen, aber ewig stehen die Berge!

Le montagne stanno ferme, gli uomoni camminano!

Humans come and go, but the mountains remain through the ages! (source: Florian Dimai, Austrian alpine guide and Conte Arthuro Franchini, Italian fellow climber ex: Luis Trenker 1931 "Berge in Flammen" = "Mountains in flames").



The Military Geologic Outline Map of Austria 1: 2.000.000

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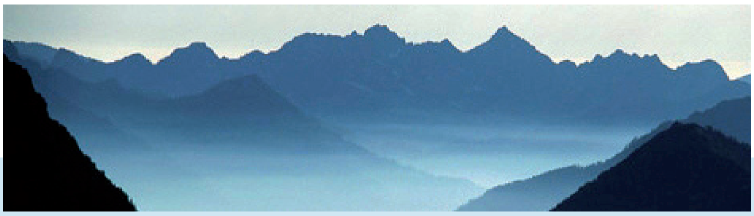
Poster presentation

On the basis of the geological outline map of the Republic of Austria 1 : 2,000,000 (without Quaternary cover), elaborated and edited by the Austrian Geological Survey, a military geologic general map of Austria was developed and designed. The evaluation of the topics trafficability, diggability, disposability of mineralic building and raw aterials, as well as the presumable occurrence of drinking water took place empirically and classifies the groups of rocks into a clear pattern of maximally 5 classes.

Manifold geologic factors determine the characteristics and the usability of soft and hard rocks. The natural variety and the changing structural patterns often cause a different behaviour of the same rock within a closer range, e.g. shearing strength, compressive strength and/or tension stress. It is sometimes pretty difficult to recognize homogeneous coherent domains in the field, to define these properties in relation to accurate position and details, and to chart these geospatial data on large-scale maps.

Therefore the reasonableness of processing small-scaled data and subject areas is to be analyzed and scrutinized, particularly with regard to a wide scope of military geologic evaluation (e. g. good to unsuited trafficability, diggability, etc.) of decisive terrain. The small-scaled maps do not contain details, that would allow any qualification in the sense „no ifs, ands or buts“, but rather the general trend (average representative properties of rocks) is crucial. The evaluation of any specific rock or assemblages of rocks, plotted as „homogeneous“ domain in the military geologic maps disregards the natural elevation relief (slope angles), with its Quaternary cover and vegetation cover etc. of Austria. The military geologic outline maps of Austria may be useful for both, operational and military-strategic levels as a decision basis.



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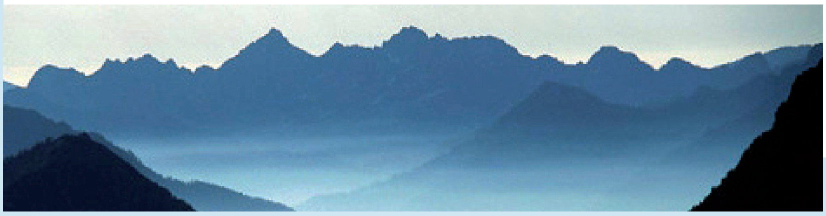

Mountainous Terrain and the Seven Weeks' War of 1866

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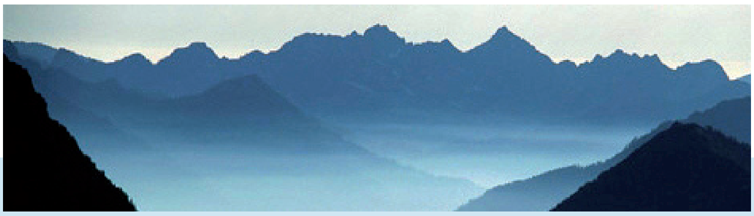
Oral presentation

The Seven Weeks' War (Austro-Prussian War) of 1866 was one of a series of wars involving Prussia which took place from 1864 to 1871, and which resulted in the creation of the German Empire.

This series of conflicts was in turn a part of a larger series of conflicts in the last half of the 19th century that demonstrated the interaction of terrain, technology, and military doctrine in an era of rapid technological change for the armies and navies involved. This paper focuses on the role mountainous terrain played in determining the outcome of the war in the critical Bohemian theater.

The Prussian army gained the initiative because of its more rapid mobilization and because of the well-planned use of the railroads for mobilization and concentration. The imperial Austrian system of regional deployment based on ethnic reliability meant that Austrian mobilization and transport into Bohemia would take much longer than the Prussian mobilization. The Prussian army, after occupying the Kingdom of Saxony, invaded Bohemia along three axes. The western axis crossed the Erz Gebirge, while the central and eastern axis crossed the Sudeten range. The mountain lines between the axes protected the Prussian mobilization and supply lines. A rail line and roads supported each axis of advance, and the Prussian Army had planned to supply its forces from their bases in Prussia and Silesia.

However, the Prussian supply service was severely constrained by the congested terrain before the climatic battle at Königgrätz, and it was only in the period after that battle that a regular supply service was reestablished.



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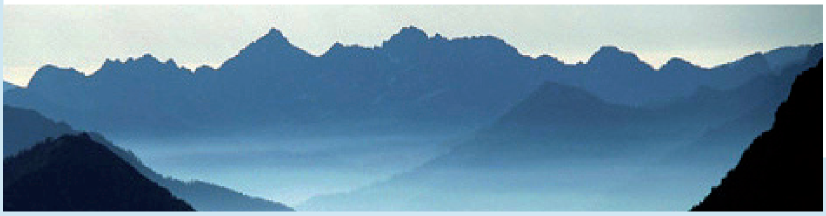

The State of Military Environmental Management in the South African National Defence Force

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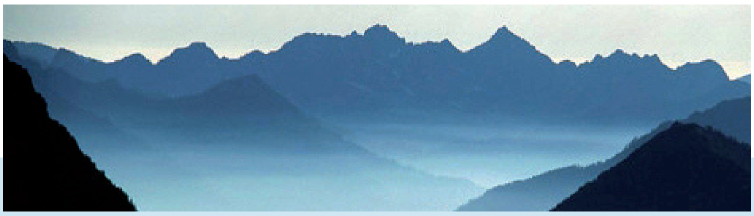
Poster presentation

In terms of environmental matters, 1970 is widely recognised as a watershed year. According to Rabie and Fuggle (2000), Rachel Carson's Silent Spring (1962) elicited response on both international and national levels. In the United States of America, the National Environmental Policy Act was signed on 1 January 1970, while South Africa declared 1970 Water Year, followed by 1973 celebrating Our Green Heritage.

Various environmental bodies were formed during the following decade, including government committees. In 1980, the White paper on a national policy regarding environmental conservation was published (Rabie & Fuggle, 2000:19). This global and national concern for the environment did not pass unnoticed by the South African military and resulted in 1977 in the first instruction to the Defence Force to look after the environment on its properties. This led in 1978 to the first ever South African policy on this matter (Godschalk, 1998:2).

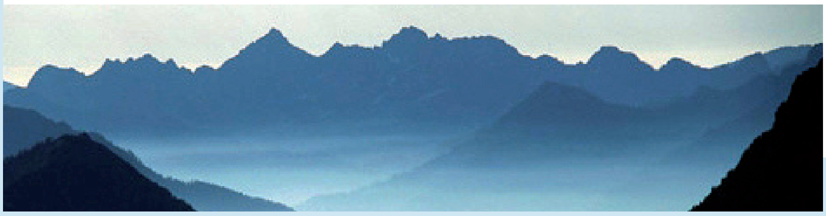
A new political dispensation in the nineties ushered in a new era of environmental consciousness, and in 1998 the National Environmental Management Act (NEMA), Act No 107 of 1998 was promulgated to streamline and consolidate South African Environmental Law. This Act required every national department that may affect the environment to compile an environmental implementation plan within one year of the promulgation of the Act and to update it at least every four years thereafter.

The environment was placed firmly amidst the day-to-day activities of the South African Department of Defence (DoD) by this legislation. An Environmental Implementation Plan (EIP) became part of South African subordinate Law with the publication in the Government Gazette in February 2001 (RSA, 2001:2), and on the 20th of February 2004 a draft Environmental Management System (EMS) for the South African Department of Defence was completed (Godschalk, 2005). After extensive testing and revision, this



EMS will be implemented (Liebenberg, 2008).

This presentation investigates the development of environmental management in the South African Department of Defence, give an overview of the present state of environmental management, and sketch possible future scenario's as far as Military Environmental management in the South African Department of Defence is concerned.



The Geopolitics of Alpine Warfare: An Empirical Assessment

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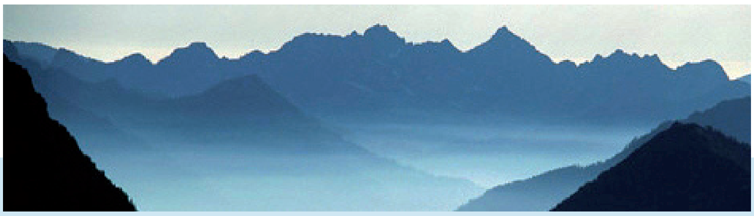
Poster presentation

The incidence of armed conflict in alpine environments has historically presented two major challenges to the conduct of successful military operations: high elevation and cold weather conditions.

While the classical canon in military science has emphasized the impact of mountainous terrain on troop mobility and the implementation of strategy and tactical approaches, both contemporary studies and field/training manuals focus more on the influence of extreme temperatures and climate conditions on the logistical capabilities and physical endurance of ground forces. At the same time, although many of the major battles of European history have been fought in alpine regions, there has been significant variation in the degree of involvement in warfare among the Alpine countries. While the armies of France, Germany and Italy have participated in major world geopolitical struggles, the force postures of other states whose territories lie within the "Alpine arc" have been characterized by the adoption of defensive strategic policies (i.e. neutrality), such as Switzerland beginning in 1815, and Austria since 1955. Even the principality of Liechtenstein, though having abolished its standing army due to budgetary constraints in 1868, did field forces in battle during the first sixty years of its existence.

The present study presents an empirical assessment of the impact of topographic, climatic and geopolitical variables on participation in militarized interstate disputes by the armed forces of seven Alpine Convention states (Austria, France, Germany, Italy, Liechtenstein, Slovenia, and Switzerland) for the years 1816 to 2001. Logistic regression analysis techniques are applied in order to determine 1), the probable level of hostility reached in an interstate dispute, 2), the likelihood that the a state's armed forces will pursue the offense or defense, and 3), the probable level of casualties sustained in an international conflict.



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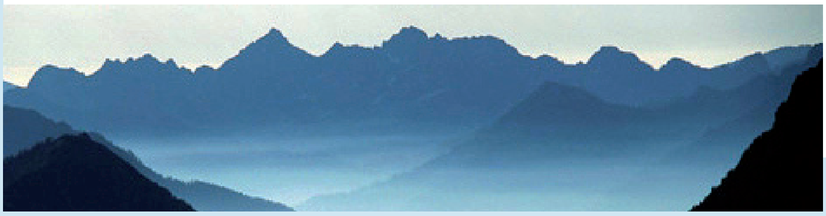

A Military Geography of the Iraqi Insurgencies

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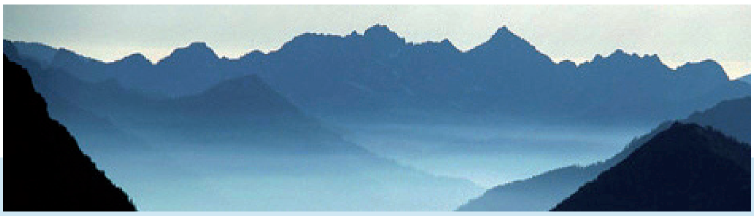
Poster presentation

While military geographic analyses of the 2003 Iraq War have addressed the traditional issue of the impact of terrain on the conduct of conventional warfare, few if any substantive studies have been produced in the subfield on the role of terrain types, slope, vegetation and physiographic structures in the post-2003 Iraq insurgency. This is most likely reflective of the fact that a majority of major combat actions involving Coalition and insurgent forces (e.g., the first and second battles of Fallujah in April and November 2004) have been primarily MOUT (Military Operations on Urban Terrain) engagements rather than typical guerilla warfare scenarios. Yet in recent years, various reports on domestic insurgent and Al-Qaeda in Iraq (AQI) activities have identified the frequent utilization of natural and physical features such as palm groves, orchards, riverbanks and deep-water artificial lakes for the purposes of cover, concealment and movement.

This study presents a framework for examining the tactical innovations of the Iraq insurgencies in the use of isolated natural spaces in training, logistics, infiltration and evasion techniques. The analysis will conduct a comparative assessment of how varying domestic insurgent or foreign terrorist organizations have exploited local geographic conditions in Iraq in order to reconcile combat or terror tactics with strategic goals, and contrast them with the historical canon of geography and strategy in insurgent warfare.



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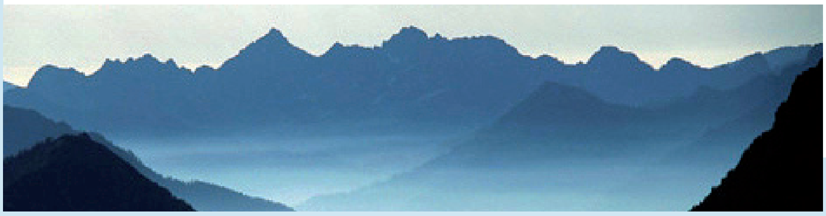

Military Geo-products for the Tactical Level in International Peace Support Missions: Examples from the Dinarian Mountain Regions

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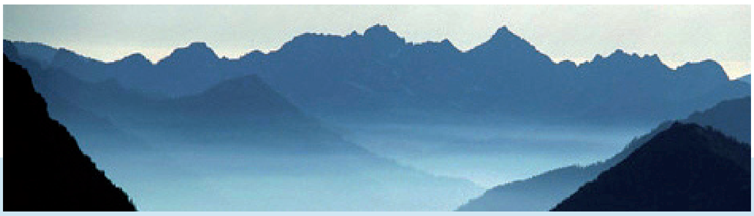
Oral presentation

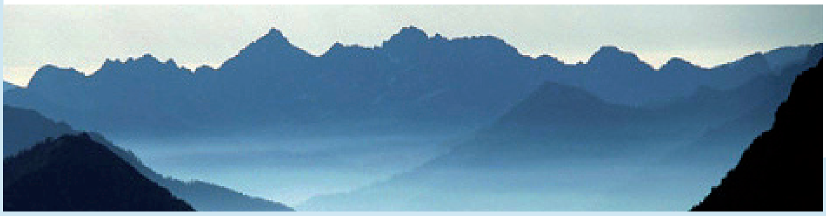
Similar to those of "cold war" scenarios, core geo-products of the "nation-building" task force in Bosnia-Herzegovina provide the necessary geographic and geologic information. Additional information about the mission theatre, located within the Dinarian Mountains, include infrastructures like roadways, railways and air traffic components. In addition, all key localities are featured. These include security and emergency agencies, military compounds and other important organizations. Geo-products such as special theme maps or regional summaries (i.e. Obstina-profiles) provide infrastructure data, which was previously the key element in total defense "cold war" geo-databases.

Geo-products for peace support missions currently include social, political and economic elements. Perhaps the most critical information in regional executive profiles is the current political situation in a given area. Updated lists of parties and political leaders, assembly seats and election percentages are also key data. During a nation building scenario the social situation in a region, comprehensive information regarding population distribution, wartime historical development, displaced people and refugees, media, religion and education are vital information for the acting security agencies. Target audiences for geo-products in modern peace support missions include joint and combined military units, security organizations, and in some cases governmental and non-governmental organizations.

Modern information technology enables "near-real time" updates of geo-products. Mass distribution of these products to the theatre and other organizations through modern networks facilitates successful current operations. The initial geo-products are enriched with regional information from current operations like "upcoming events", "observations and assessments" and "popular attitudes". Core geo-products on the tactical level in peace support



missions need to be adapted to follow a more multidisciplinary approach than that of the "Cold War" period. Social, political and economic issues must be the new foci. Regional assessments should be digitally produced in "near-realtime" and modified and made available to a wide range of users.



Cities in War : Geographical Efficiency of War and Territorializm

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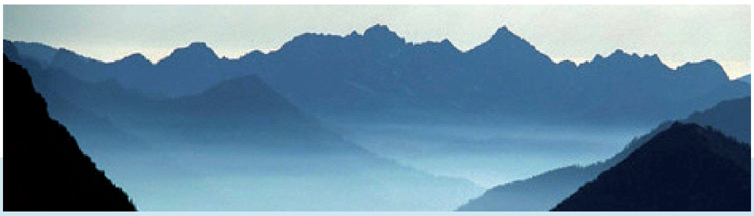
Poster presentation

The geographical efficiency of war in the cities seems obvious at first sight: the material destruction of certain buildings or whole areas feeds the collective views. Cities that were once anonymous thus become very famous through the publicized images of pillages, arsons, bombings, snipers' shootings…

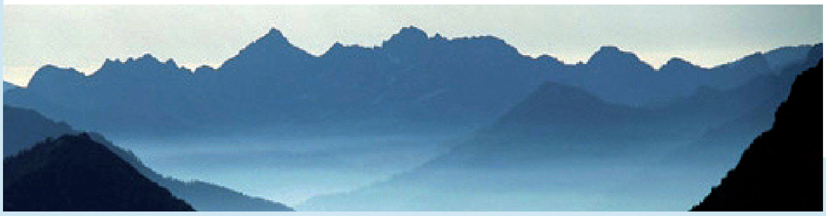
But this geographic efficiency of war can also be indirect: through the reformation of social, identity-related, political and economical bonds, the urban population is deeply transformed and on a permanent basis. The presentation offers an analysis of the different temporalities and territorializations that transform the living in cities, through an attempt of conceptualizing, in order to implement tools that allow military to better match the specific needs of each city both during times of war and peacekeeping. Different levels need to be taken into account: on the one hand, the city is a strategic, politic, economic, social and identity stake. Shelter or target, it is always a symbol for military actions.

On the other hand, the analysis will present the evolution of the different areas according to their role (both strategic and symbolic) in war, through the different temporalities of war. The emergence of militia areas shatters the social mechanism of the city. We will then distinguish between several types of cities that experience differentiated social and identity transformations : the divided city (as will show the analysis of the city of Mitrovica in Kosovo) ; the different modalities of the intercultural city (like Sarajevo which used to be a symbol of exchange and encounter, or Beirut, a city where there used to be exchanges but they were limited to specific areas and highly codified forms of territorialization), and the homogenized city (through the example of Kabul).

Territorialization through violence deeply transforms the city by recreating new forms of spatiality which the military need to take into account in order to make the spatial



deployment and its missions' objectives evolve, to be able to match the needs of the population in the best possible way and to adapt its security networking to the evolutions of the militia territories and criminalized territories.



Killer Carbonates: A Tour of Antietam Battlefield, Western Maryland, USA

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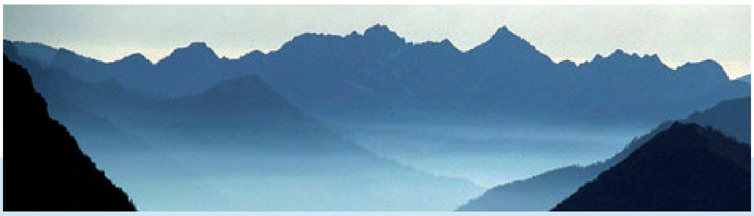
Oral presentation

The geology of battlefields rarely affects the outcome of battle. There are, however, a few exceptions to this statement. One such battlefield is where the Battle of Antietam occurred during the American Civil War in 1862. The battle, still the single bloodiest day in US history with 23,100 casualties, was fought between Confederate General Robert E. Lee and Union General George B. McClellan near Sharpsburg in western Maryland.

Lee used the geology and structure of the region in choosing the invasion route, in a major delaying tactic prior to the battle (the Battle of South Mountain), and in the battle itself. Antietam battlefield is underlain by two distinctively different geologic units that create two very different terrains. The Conococheague Formation is a relatively pure, high calcium carbonate limestone that produces an open, low relief topography, whereas the Elbrook Formation is a shaly dolomite that forms a more dissected physiography characterized by many small hills and ravines. Consequently, casualty rates are significantly higher where combat occurred on the Conococheague outcrop area, which provided little cover and concealment for soldiers. In previous work, we have shown the influence of geology on the battle by using standard morphometric measures to quantify terrain variables and relate these data to the numbers of killed and wounded during the battle.

In this presentation, we will guide you through the battle on the ground, showing how the combination of terrain and geology affected the outcome of the battle and the distribution of casualties across the battlefield.



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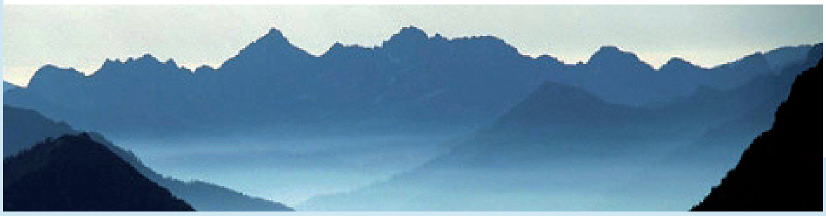

Mining Warfare in the Wytschaete Ridge (Flanders, Belgium) 1914-1917 – Advantages and Disadvantages of High Ground Emplacements

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Oral presentation

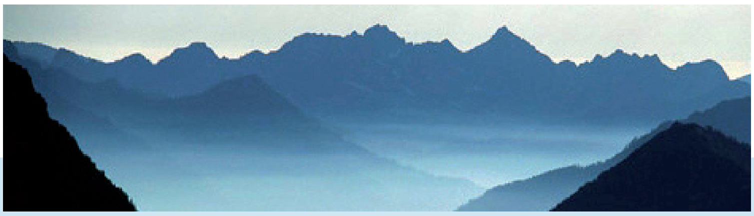
Since the First Ypres in November 1914, German troops had been holding the strategically important ridge stretching from Height 59/60 east of Ypres to the Ploegsteert Wood. The approx. 15km long ridge is rising only max. 65m high above the plain stretching towards the west. From this high position, the Germans had a clear view of the British trenches and supply lines and were able to control them.

The same as on the entire western front, fierce subsurface battles took place in Flanders, too, because the resources and troops available did not allow to break through above ground. Both sides sent strong Mining Forces beneath the surface, where many of them perished in the fighting that was increasingly getting more brutal. Those involved not only had to be proficient in the principles of mining; optimum use of the local geological situation, the subsurface terrain, was essential, too.

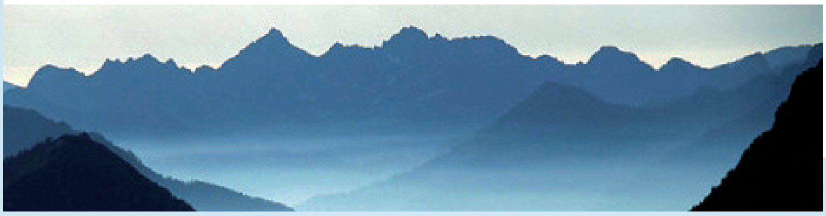
In the special case of the Wytschaete Ridge, the high ground emplacements of the Germans eventually turned out to be a disadvantage, because - thanks to the favourable geological conditions – the Allies managed to launch their subsurface assault with relative ease. The German miners first had to overcome the problem of waterlogged strata and gain the depth that was necessary for fighting the enemy effectively. The allied miners benefited from strata that were extraordinarily suitable for mining just below the allied trenches and from consistent and long-term planning supported by military geologists right from the beginning. Consequently, they were able to use this chance for gaining an uncatchable lead over the Germans.

On June 7th , 1917, after several days of shelling, the Wytschaete Ridge was shaken violently by 19 simultaneously fired mines. Several hundred German soldiers were killed on the spot and the Wytschaete Ridge was taken by the Allied forces after fighting that lasted several days.

However, anyone who believes that this "medieval" way of fighting no longer exists in our times is wrong. Re-



cent examples from Palestine show that nobody can guarantee that subsurface attacks are impossible today. Under suitable geological conditions such as in loess areas, the possibility of mining attacks on fortified installations must always be expected.



The Geological and Geotechnical Aspects of Deeply Buried Military Targets in the Perspective of Network Centric Warfare Doctrine

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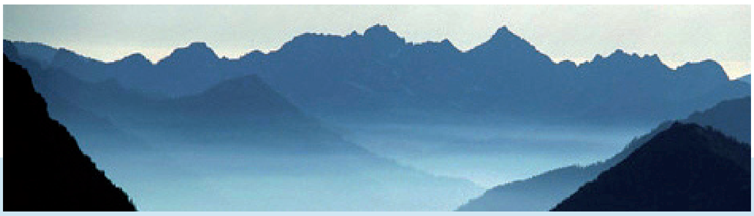
Poster presentation

Network centric warfare (e.g. Network Enabled Capability) is a new military doctrine and operational concept for the future warfare. This military doctrine translate an information advantage, enabled in part by information technology (e.g. GIS/GPS tehnology), into a competitive war fighting advantage for troops on a battlefield. The goal of this military doctrine is "right information, right place, and right time". In focus of C4ISTAR (Command, Control, Communications, Computers, I - intelligence, and STAR - Surveillance, Target Acquisition and Reconnaissance) is destroying the enemy C^3, key weapons, eqipments and infrastructure wich is often heavy entrenchment in bedrock (e.g. Tora Bora mountain). Geological information in an interaction of the other military geoinformation may be the key for this goal. Military geology site analysis required to define subsurface stratigraphy, geological conditions, as well as geotechnical and engineering properties of the underlying materials.

The paper examines, from theoretical and the strategic perspectives, the underground military facility under different geological, environmental and critical data input for projectile penetration prediction to destroy hardened and deeply buried military targets in the context of conventional warfare. Geotechnical characteristics of geomatrials significantly influence on effects of projectile impact and penetrability, underground projectile trajectories and crater geometry.

Information about topography and geologic setting can be used to select the best weapon, conceptual model and methods of the attack. Hypothetically, that successful attack may be multiple projectile impacts of serial projectile penetrations to the same point, one after another, in a straight line but only if CEP (circular error probable) of select projectiles and geological environmental made it possible. The total penetration depth and damage accumulates of multiple serial projectile penetrations to the same point can only be geologically estimated. Geology is



important for both detecting underground military installations and assessing potential weapon effectiveness and target vulnerabilities.

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