

**Department of Geography
University of Western Ontario,
Geography 3000y Section 3: Kentucky Field Camp
Course Outline and Briefing (2016)**

1. Objective

Field Camp is intended to provide an intensive, multiday experience directed to reading and interpreting the environment in a geographical context. The Kentucky field camp provides a novel experience involving a “karst” landscape where both physical and human geographies are underpinned by ubiquitous underground drainage.

2. Personnel

Leader: Dr Chris Smart, SSC 1402 (csmart@uwo.ca, 519 661 2111 x 85007)

Assistant: Lara Middleton (lmiddle7@uwo.ca)

3. Background: Karst Landscapes

Karst is a noun and adjective applied to landscapes developed on soluble rocks like limestone where the majority of runoff travels through underground cave streams. Cracks in the rock are opened up over time by percolating water, increasing the permeability of the bedrock. As a result, there is little surface water; rainfall and rivers disappear underground, where they join up into subterranean river systems and finally emerge as springs.

Much of our familiar landscape is “fluvial” with river networks nestling in integrated valley systems. In karst, rivers occupy cave networks and the surface landscape is much less coherent, featuring closed depressions and often the dry remnants of former valley systems. In conventional landscapes, rivers and surface runoff progressively denude (lower) the landscape removing most of the evidence of its former condition. In karst, as erosion progresses, the cave stream drops to new levels and old caves are left as abandoned (“dry”) passageways that can be explored. The result can be a complex network accumulating over millions of years as exemplified by Mammoth Cave.

Karst can be challenging for its resident people. Water may be hard to obtain, the ground can collapse unpredictably, floods (paradoxically) can be all too frequent and pollution is extremely difficult to control as contaminants can travel rapidly underground into water supplies.

Karst Processes

Mammoth Cave National Park is a UNESCO World Heritage Site in Central Kentucky containing the longest single cave system in the world. It highlights many aspects of the karst landscape and allows us to travel both above and below ground to understand how the system evolves and operates.

Dissolution of limestone is driven by dissolved carbon dioxide creating a weak acid. Rain water and stream water are mildly acidic because they hold only a small amount of carbon dioxide. However, when rain water soaks through soil it picks up considerably more carbon dioxide and is much more acidic.

The way in which karst develops depends on the way in which rain and rivers contact the limestone. Non karst surface streams deliver a lot of (possibly dirty) water to a particular point or line of attack where they flow onto the limestone. They may develop caves where they sink underground or sometimes cut gorges through the limestone. Stream sinks typically lead into caves that join with other caves before emerging at a spring (or more briefly appear at a karst “window”). Rain falling directly on limestone may erode pits and runnels, but does little more. In contrast, rain infiltrating into the soil becomes much more acidic, and aggressively erodes the underlying limestone rock. Rain water is widely dispersed over the landscape and so opens up numerous small fractures that coalesce into closed depressions. Dissolution decreases with depth, so karst often has a characteristic highly eroded “epikarst” zone near the surface, but becomes integrated into fewer, smaller channels at depth. Like Cinderella, soil water loses its magic dissolution capability if it encounters a normal atmosphere for example where it drips from a cave roof. It may then deposit extensive “speleothems” better known as stalactites and stalagmites.

Understanding karst requires a basic understanding of geology, particularly, the distribution of soluble (limestone) and insoluble (sandstone, shale) rocks (Figures 1 &2). The Mammoth Cave karst system starts

from the insoluble Glasgow uplands in the south. Rivers gather in this area and flow north to where they meet limestone and sink (disappear underground) into caves that run beneath area of limestone that has been heavily eroded by soil water dissolution (and collapse of underlying caves) to form the Sinkhole Plain. Further north the limestone lies under a protective layer of sandstone to form the Chester Uplands. Most of Mammoth Cave national Park lies in this area as the sandstone caprock has preserved caves for millions of years. Cave streams run through the lowest levels of the cave to finally emerge at numerous springs along the deeply incised green River.

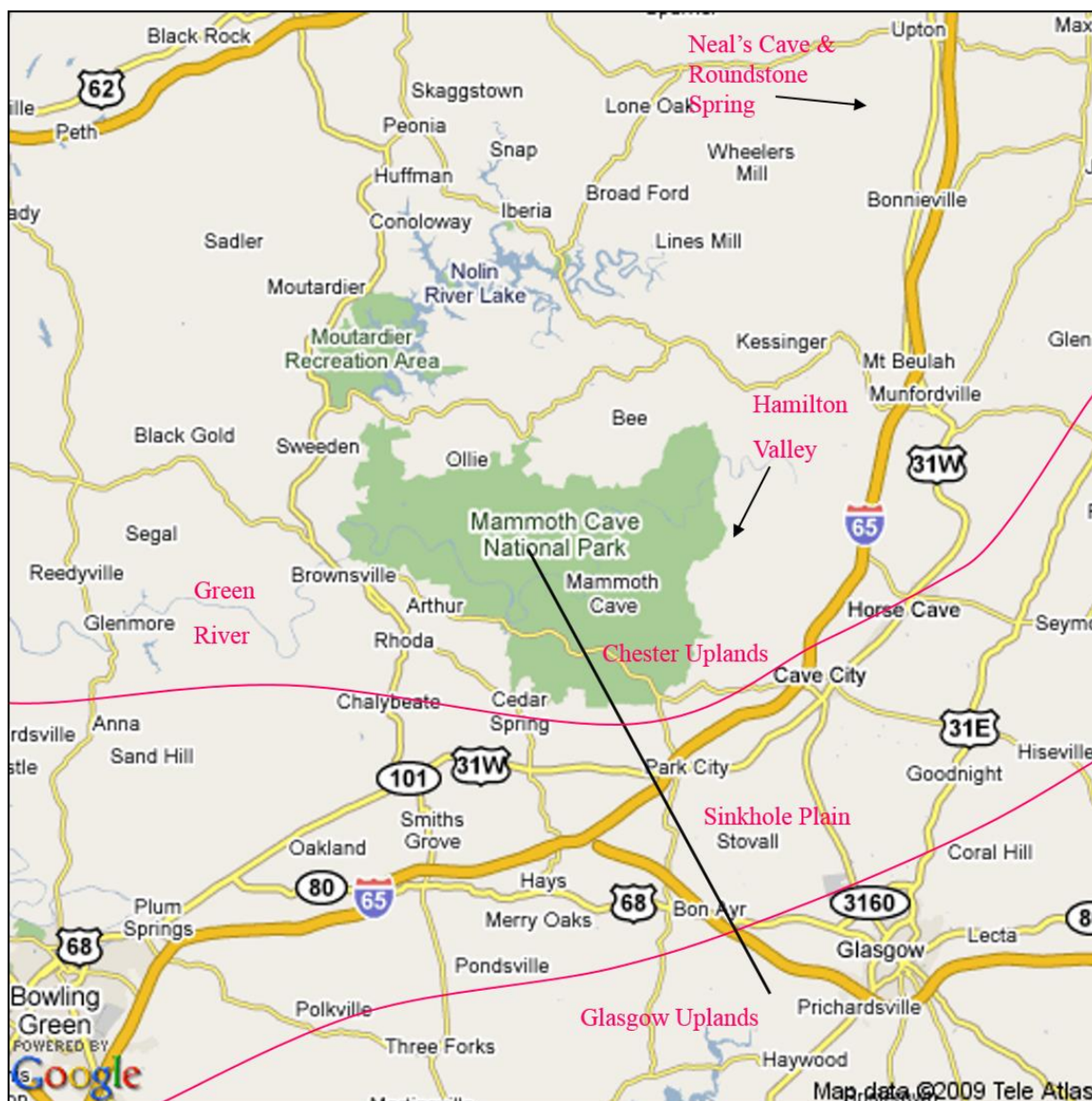


Figure 1. Central Kentucky Karst: key landscape units and locations. Hamilton Valley is the base of operations.

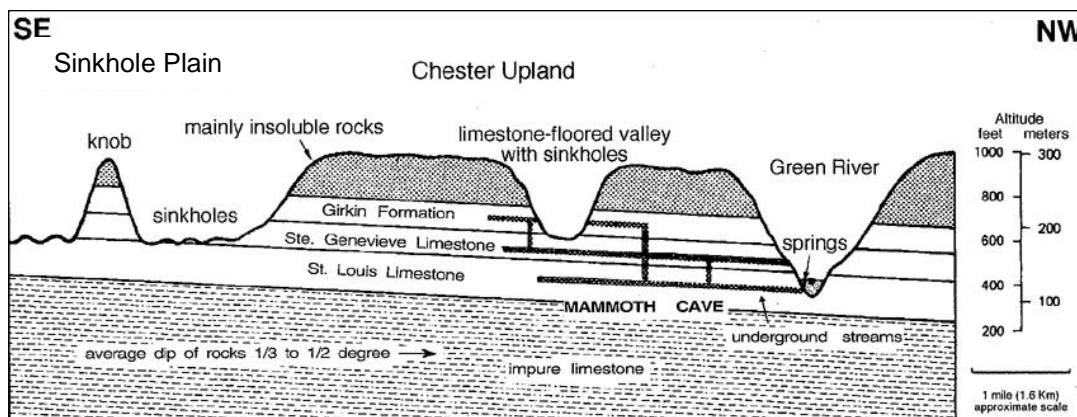


Figure 2. Cross-section through Mammoth cave national park (Black line on map above). Streams flow from the Glasgow uplands into the Sinkhole Plain and under the Chester Uplands to emerge as springs along the Green River.

Karst Resources

The first problem for those living in karst is obtaining reliable water supply. Initially settlements focused on springs or karst windows and avoided the dry areas around. Occasionally wells could be dug, but often proved unreliable. This constraint was reduced when drilling was developed allowing boreholes wherever anyone wanted. However, a very productive well could be near those yielding very little water. The secret of course, was that the productive wells had been lucky enough to hit an underground river in a cave. The advantage of good supply was often more than offset by the attendant risks of pollution. A cave river is very similar to a surface river in its levels of bacteria, nutrients and artificial chemicals. In general, a conventional water distribution network drawing on a surface water reservoir has now replaced many of the wells.

Closed depressions are characteristic of karst, but they vary in origin. Some are collapses into underlying caves. Others are caused by concentrated infiltration eroding the bedrock. Others are the remnants of former stream networks. It is often difficult to tell them apart because of the typically rich red residual soil that mantles the underlying bedrock. This soil can plug up the openings in the bedrock, especially if disturbed. Construction or farming often results in sediment infilling of depressions, which can pond water during storms. When these overflow into adjacent depressions the problem is exacerbated resulting in much deeper and more frequent floods than anticipated. Similarly, the land underlain by caves and epikarst may be weak or unstable, so that it can collapse quite spontaneously undermining highways and foundations. It has also been recognised, somewhat belatedly that karst environments host particularly unusual and vulnerable ecosystems. Conservation measures often prove difficult to devise even when the problem is recognised. For example, Mammoth Cave National Park was deliberately (and forcefully) acquired to encompass the known cave at the time. Since then it has been recognised that most of the streams hosting cave life originate in the polluted Sinkhole Plain outside the jurisdiction of the Park.

Solutions to these problems have been slow to develop as the difficulties are not obvious locally and the underground flow routes can be complex. Pioneering work in the region has resulted in significant headway in mapping underground flow routes using cave maps, dye tracing and groundwater monitoring. We will be studying and using these maps in our own studies of both rural and urban karst.

4. Itinerary

The group will travel by van ~960km to Mammoth Cave National Park, KY. We will be staying at the Cave Research Foundation base at Hamilton Valley, immediately east of MCNP. Accommodation will be in bunkhouses and the adjacent facility building. Catering will be largely our own efforts (see below). From Hamilton Valley, day trips will run out to the surrounding region. Evenings after meals, small tutorial sessions will be held to discuss and review the day's topic to allow questions, clarification and exploration. See the itinerary below. (Note final scheduling is still contingent on access and availability of some local hosts.)

Day: 2013	Itinerary	Objective	Notes:
1. Sat. 26	London-Mammoth Cave	Travel	<i>Depart SSC Loading Bay 8:00 am. Arr.: Hamilton Valley, KY. ~17:30 CST</i>
2. Sun 27	Sinkhole Plain-Mammoth Cave NP	Surface hydrology & geomorphology	<i>Geology, landscape & landforms, evolution, hydrology.</i>
3. Mon 28	Mammoth Cave NP	Caves: forms, origin, development & function	<i>Cave evolution, cave forms, cave sediments, cave hydrology.</i>
4. Tues 29	Sinkhole Plain, Hidden River Cave *	Mapping and groundwater pollution	<i>Water contamination: cause, impact, diagnosis, remediation, biology</i>
5. Wed 30	Mammoth Cave (?) Bowling Green, KY	Mapping and urban karst	<i>Urban contamination, drainage, foundations (Evening in Bowling Green)</i>
6. Thu 01	Neal's Cave & Roundstone Spring	Cave mapping and project (TBA)	<i>Evening BBQ and clean up</i>
7. Fri 02	Mammoth Cave-London	Travel	<i>Depart HV. 8:00ish CST Arrive London, ~7:30pm</i>

***HIDDEN RIVER CAVE TOUR CONSIDERATIONS:** This tour should be considered very strenuous and includes bending and crawling. This tour is not recommended for anyone that has claustrophobia, breathing or walking difficulties, heart conditions or other physical impairments. Restrooms are not available inside the cave.

5. Resources

Students are expected to have developed a basic comprehension of karst and the region based on the assigned reading prior to the trip. Most students will find that they need to work hard to comprehend the landscape forms and processes and to orientate themselves in the rolling country and its towns. The Sunday surface tour provides a foundation that is developed in each subsequent day. Readings are posted on OWL or can be emailed on request. Additional background information is available in the library and on-line. An accessible starting point is to look up the chapter on karst that can be found in most geomorphology text books. There are a number of more specialised text books on karst and Mammoth cave in particular. Some of these will be brought on the trip and may be borrowed.

Web resources are superabundant (see Web Resources document). *Read and understand selected materials rather than accumulating reams of unread pages.*

6. Preparation

a) *Three preparatory meetings* will be held to organise logistics and encourage development of background knowledge prior to the trip.

1. Meet & greet. Outline to the trip and responsibilities etc. (prep. Read this outline and define “karst”)
2. Background to karst environments and land use. (read on karst, mammoth cave & management, using provided and other resources)
3. Cave contamination exercise (prep. Explore Hidden River Cave and contaminant sources using reading, Google earth and Streetview.)

b) Some *logistic preparation* is required (passport, insurance, clothing, headlight etc. see below).

c) *Readings* will be posted or are available on-line.

1. Kentucky is Karst Country (Currens, http://oeopos.ca.uky.edu/files/Ky_Karst.pdf).
2. Map and information on Mammoth Cave National park
http://kgs.uky.edu/kgsweb/olops/pub/kgs/mcs186_12.pdf
3. Palmer, A.N, 1990. A Geological guide to mammoth Cave National Park. html once the basic briefings have been completed, you can read the entire book, not worrying too much about detail. Alternatively, a more tactical priority might be...

a) Initial reading:

- Ch3, Exploration history
- Part of Ch5, (59-67) Rock formations at Mammoth Cave
- Ch7 Cave Science
- Ch 11 Underground sculpture, decoration and deposits.

b) Follow up reading:

- Ch2. The cave and its surroundings
- Ch4. The regional picture
- Ch8 Underground water and how it moves
- Ch10 The cave as a drainage system (108-114)
- Ch 14 Historic tour 152-164.

7. Assessment and Deliverables

- a) Preparation: 30% based on evidence for prior reading, exercise informed questions and self-briefing assessed at preparation meetings, in the field and during evening tutorials. Asking sensible questions is more important than trying to show off what you know.
- b) Participation: 30% based on daily review, behaviour, timeliness, preparation, contributions (academic and domestic) and overall engagement and responsibility in the trip.
- c) Term paper: 40%. Each student is required to submit an original (five pages double spaced text) written paper on karst, on a topic of their choice particularly drawing on information and examples culled during the field trip. The paper is due (in electronic Word format) Monday ~~23~~ November 201~~5~~⁴ Please submit all term papers as single attachments through OWL, providing a Turnitin report on textual originality.

Possible term paper topics:

1. Karst and regional geology, 2. Karst landscape & landforms, 3. Karst hydrology,
4. Cave evolution, 5. Cave forms., 6. Cave sediments., 7. Cave hydrology., 8. Cave ecology,
9. Water contamination: cause & impact, 10. Water contamination: diagnosis & remediation,
11. Urban contamination. 12. Urban Drainage & Foundations, 13. Urban Planning, etc.

7. Health, Safety and Deportment

a) *Behaviour*

It is important to be considerate of the functioning of the group through timeliness, attentiveness and responsibility. Students not ready on time may be left for the day at the base. As we are self-catering, all participants must contribute to domestic duties so we leave the centre cleaner than when we arrived.

The academic goal of this field trip is to develop skill in reading the environment, interpreting the observations and integrating them with existing knowledge. Students are expected to show appropriate preparation, constructive contribution and to ask salient questions. How much we do and learn will rest on students' contributions and reliability.

(Note 30% of the mark for the trip is assessed against "participation" which includes general behaviour and contribution as well as academic engagement.)

b) *International Travel*

As guests of the United States, the State of Kentucky and various institutions and municipalities, it is understood that we will behave with courtesy and respect in following civilised protocol and applicable law. This translates into good manners and common sense. Kentucky is culturally somewhat different from Ontario; with stronger emphasis on religion and independence than we might be accustomed to. Many counties in Kentucky are "dry"; "wet" counties have a legal drinking age of 21 years. Alcohol will not be part of this trip.

You are required to have a current Canadian Passport and where appropriate the necessary visa to cross the US border and return to Canada Those lacking the appropriate documentation will remain in Canada with little prospect of a refund. For customs, do not attempt to smuggle materials across the border (this includes taking fresh fruit into the USA). Illegal drugs are absolutely forbidden and can lead to incarceration, and criminal prosecution for all members of the trip. Bring any medications in the dispensing containers.

c) *General Safety*

Effectiveness in the field requires the ability to be aware of and respond appropriately to hazards while concentrating on the work in hand. Definition and compliance with safety requirements is a start. However, an awareness of hazards and making an appropriate response requires that you stay alert and flexible despite competing demands. Group field work requires group awareness and shared responsibility becomes a priority. Lack of attention, fatigue and disrespect for the group amplify minor hazards.

On this trip, field work will include working near busy roads, in underground caves (see below), near rivers and in forest. **A reasonable level of fitness and agility is assumed.** Familiar hazards include traffic, steep slopes, tripping etc. In addition, loose rock, holes, sudden drops and low ceilings can all pose hazards {wear a helmet and gloves, look where you are going}. In Kentucky, poison ivy is common and

rampageous {recognise the leaf and climbing forms {<http://www.wikihow.com/Identify-Poison-Ivy> }; venomous snakes may be encountered occasionally {watch the ground around cave entrances}, ticks and chiggers can be irritating {keep out of long grass, strip and check your clothing on return; ticks prefer tight warm spots.}.

If a hazard exists, then the group must be made aware of it. If you consider yourself or anyone else to be outside their personal capabilities, then ensure that this is addressed by the group leaders.

No one should wander off alone. Endeavour to keep together to avoid separation. Fast movers have to ensure their followers are keeping up. Groups working independently should plan their itinerary and precautions in advance and make them explicitly known to the leaders.

Minor hazards encountered should initially be communicated as additions to one's personal awareness "portfolio". Major hazards such as dangerous traffic, drops or deep water should always be pointed out. Do not assume that someone else will point out all risks, but remain aware of and communicate perceived hazards.

In the event of a minor accident or injury (minor scrapes, bumps and abrasions are common in caves and field work), make sure the group is aware of this and remains cohesive while things are resolved. There will normally be a first aid kit with every group.

In the event of a more serious accident, then remain calm and engaged in working as a team to ensure the following:

- (i) Undertake a rapid assessment of the situation particularly if leadership is compromised.
- (ii) Determine if others are at risk and if possible ensure their safety.
- (iii) If appropriate reduce or remove the risk.
- (iv) Provide first aid assistance to anyone injured. Note do not move a person with possible spinal or head injuries unless it is imperative for their survival and pain control.
- (v) Assess the situation and call for emergency assistance. If underground, designate exit and resident teams. Ensure the exit team knows the way out and can inform the emergency response unit of the situation and location. (Kentucky emergency response 911, 1-800-255-2587(including cave rescue), or specifically cave rescue (502) 564-7815).
- (vi) The resident team maintain surveillance of the injured party. Be prepared for strain and hypothermia (chilling).

d) The nearest hospitals:

Mammoth Cave: Caverna Memorial Hospital 1501 S. Dixie Hwy (31W) Horse (270) 786-2191 Located on the Cave City-Horse Cave Road. 4km from Cave City. 2.5 km from Horse Cave on the north side of the road

Bowling Green: Greenview regional Hospital Scottsville Road (ky 231) Bowling green. 3.7 km North of I65 junction 22. Telephone: (270) 793-1000

e) *Caving: practice and impact*

Working in a cave is like learning to ride a bike, until you get coordinated things get in your way a lot. Doing is the best way of learning. However, some advice can be provided.

- (i) The ground is not guaranteed smooth, flat, and firm. It can be rough, loose and slippery and abrasive. Wear *robust shoes and gloves*.
- (ii) The ceiling is not always >2 m above the floor. Watch your head and don't move without your *helmet* securely attached.
- (iii) The only light comes from your *headlight*. Make sure it works, and carry spare light and batteries. Direct vision is reasonable, peripheral vision negligible. So you have to point your head (light) where relevant. Operationally, this is the floor immediately in front of you. But the walls, ceiling and distant vistas are much more interesting. Stop if you want to look at the latter. Apparently black bits of floor are usually holes or pools of water. Avoid shining your light into people's eyes.

- (iv) “Dry” caves can be quite wet (I nearly drowned in one once.) “Wet” caves have streams in them and so add water hazards to the mix. (I nearly drowned here too.)
- (v) Keep together, have a spare light and some food. Progress at the rate of the slowest member of the team. Do not wander off either individually or as a group.
- (vi) Caves can be challenging to navigate (complicated by the darkness). It should not be an issue on this trip, but try to spot and note junctions. Make a habit of looking back as you go because a passage looks completely different on return.
- (vii) Try to understand the geography of the cave route by studying cave maps and understanding the progress of a trip, so you know where you are at any time. If you become lost, stay put.

f) *Conservation*

Caves are particularly vulnerable environments as our unnatural presence poses an exceptional threat to the normally stable climate, geology, hydrology and biology. Beware of causing physical damage to rocks, sediments and speleothems (do not touch stalactites etc.) that may be millions of years in age. Consider that someone may drink the water you encounter. Finally, cave life is tenuous, vulnerable and extremely limited in its capacity to respond to our presence. Cave softly: watch your step, leave the minimum trace behind and removing nothing (other than someone else’s garbage).

Bats in Kentucky and throughout NE North America are falling victim to White Nose Syndrome. This fungal agent is present in Kentucky and Mammoth Cave and is readily spread on clothing. We will follow a sterilisation protocol that has been developed to reduce the risk of accidentally transmitting the disease.

g) *Contact Information at Hamilton Valley*

For Emergency Contact Only: Cave Research Foundation at Hamilton Valley 270-773-8955

There is wireless internet available (mostly) at Hamilton Valley.

Equipment list Kentucky field trip

Individual equipment

Please limit the volume of personal items as much as possible for your own travel comfort. It is likely to be quite warm (day 20-30 C, night 10-20 C and possibly humid). Caves are cooler, but comfortable. You will get muddy, and sometimes wet crawling through some caves.

1. Passport and visa (international students).
2. Health: personal medication, notification of potential problems, allergies, sensitivities, *out of province health insurance*, contact information.
3. Cash: for occasional lunches, souvenirs, meals on the road (~us\$100). Credit card.
4. Academic tools: Camera, field notebook, paper, writing tools, handout information, Smartphone.
5. Cave clothing: spare batteries, small flashlight, coveralls or equivalent rough clothing e.g. jeans and jean jacket), rubberised gardening gloves, rugged small pack, camera protection, tee shirt, shorts, underwear/swim suit, towel. Rough boots and need-no-more socks. (We will provide a departmental headlight, helmet and large garbage bags for dirty gear and for seat covers).
6. Field and travel clothing (e.g. shorts, strong running shoes), water proofs. [two travel days and half day and evening in Bowling Green, eating in informal restaurants. Otherwise, we will be in the bush or underground. Sleep wear for four person bunkroom and 20m outdoor walk to bathroom.
7. Personal toiletries, sun screen, basic first aid kit (anti-itch medication, band aids and mild pain relief).
8. Sleeping bag (light weight), pillow or equivalents. (I use a single fitted sheet that stretches over the mattresses provided and light sleeping bag.)

Reading Sources: E-resources posted on Owl: many other on-line resources

1. Palmer, A.N. 1990 A geological guide to Mammoth Cave National park. Zephyrus Press

2. Palmer, A.N., 2007. Cave Geology. Cave Books. (This book and others will be available for loan from C Smart.)
3. Quinlan, J.M., and Ewers, R.O. 1986. Groundwater flow in the Mammoth Cave Area Kentucky with emphasis on principles, contamination dispersal, instrumentation for monitoring water quality and other methods of study. Field trip guide. Environmental Problems in Karst Terranes and their solutions.
4. Crawford, N.C, 1986. Karst hydrologic problems associated with urban development: groundwater contamination, hazardous fumes, sinkhole flooding, and sinkhole collapse in the Bowling Green Area, Kentucky. Field trip guide. Environmental Problems in Karst Terranes and their solutions.

Maps and figures are also posted on OWL.

UWO required Information for Students

Note due to the nature of the field course, the options for medical accommodation and accessibility are limited. Nevertheless, all reasonable efforts will be made in these respects.

Statement on Academic Offences

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf.

All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

Mental Health

If you or someone you know is experiencing distress, there are several resources here at Western to assist you. Please visit the site below for more information on mental health resources:

<http://www.uwo.ca/uwocom/mentalhealth/>.

Western's commitment to accessibility

The University of Western Ontario is committed to achieving barrier free accessibility for persons studying, visiting and working at Western.

Please contact the course instructor if you require material in an alternate format or if you require any other arrangements to make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

Support Services

Registrarial Services: <http://www.registrar.uwo.ca/>

Student Development Services: <http://www.sdc.uwo.ca/>