



Lost in Space? Find Your Place with Global Positioning Systems

by Tom Heck

Some of you may have wondered about the note in our previous *Newsletter* concerning the conversion of the Bismarck GPS Community Base Station to a CORS (continuously operating reference station) site. The new base station provides many GPS users with free access to very high quality data to make post-process differential corrections to their field data. This will mainly benefit moderate to high-end users like surveyors and scientists, but even some casual GPS users can benefit with the right equipment and software.

What is the base station and what does it do? The base station consists of a computer, a GPS receiver, an antenna, assorted cables, and software. GPS signals are received at the antenna, pass through the cables to the receiver, are processed and copied to the computer where the software organizes and stores the data. The base station continuously records the signals from all GPS satellites that rise above the horizon over Bismarck. The new equipment that we installed at the base station is “geodetic grade”, the most precise grade available. In addition, the coordinates (latitude, longitude, and elevation) of the base station have been precisely calculated by the National Geodetic Survey, making it a point in the High Accuracy Reference Network (HARN) and, as previously reported, we are now part of the “National CORS” network. The combination means that you cannot obtain better GPS base-station data than these.

How will users benefit? GPS users recording in the field will occupy a location for a period while recording GPS signals. The receiver will process those signals and calculate coordinates for the position. The accuracy of the receiver, the length of time one occupies the position, and how frequently data are recorded, will all affect the accuracy of the calculations. Signal errors can also degrade the accuracy of the recordings. Some sources of error are satellite clock errors, perturbations of satellite orbits, refraction of satellite signals through the atmosphere, and multi-path interference, i.e., reflection of signals off trees, buildings, and other objects. To improve the accuracy of a location’s coordinates, the field readings are downloaded onto a computer, and a “post-process differential correction” is calculated using data from a GPS base station. Because a base station is recording at a known location, any differences between the location calculated from satellite data and the known position are errors which are removed from the field data by the differential correction software.

There is a catch though. The farther one is from a base station the less the differential correction software is able to correct the field data, because the ray-paths of the satellite signals recorded at the base station and the field location are increasingly different. The Bismarck base-station data have been used successfully to differentially correct field data collected up to 200 miles (320 km) from Bismarck. So, if you have a need for highly accurate locations, you too can perform post-process differential correction with the necessary hardware and software, both computer and GPS, and internet access.

Some of you may be high-end GPS users, who are interested in getting more precise locations using OPUS. OPUS stands for the National Geodetic Survey’s (NGS) On-line Positioning User Service. There are some restrictions though on what and how data can be submitted. First, the NGS will not publish coordinates outside the U. S. Second, there must be at least two hours of field data recorded at a stationary antenna and the data must be dual frequency carrier-phase (L1 and L2). Third, the submitted field data must be in uncompressed Rinex format, in ASCII, and the data file name must conform to a specified standard. You must also inform NGS of your type of antenna and the height of the antenna above the ground. A definite commitment in time and resources is required to use the service, but what you obtain in return is a highly precise location, capable of being a bench mark. All it costs is time. This accuracy is achieved by the software written by the NGS, which takes data from the three nearest CORS base stations to determine your field location(s). Short of spending hundreds or thousands of dollars to hire a survey crew, there is no method of obtaining equally accurate results that I am aware of. Most of us will not need results that are this accurate but for those of you who do, OPUS is there.

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Lewis and Clark Research in Philadelphia

Ed Murphy visited the Academy of Natural Science of Philadelphia and the American Philosophical Society in Philadelphia in March. Murphy was looking for rock and mineral specimens collected by Lewis and Clark in North Dakota. Three rock and

mineral specimens in the Academy of Natural Sciences mineral collection had previously been identified as specimens sent back by the Corps of Discovery from Fort Mandan. In addition, most of the journals of the Lewis and Clark Expedition are housed at the American Philosophical Society. Murphy was doing research for a book that John Hoganson and he are writing entitled *A Guide to the Geology Along the Lewis and Clark Trail in North Dakota*. The book is scheduled for release later this year.

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NDGS Geologists in the Public Eye

On February 18, 2002, John Bluemle traveled to the heart of the Williston Basin and gave a presentation entitled, "The Future of Oil in North Dakota," to the Rotary Club of Williston.

On the weekend of April 25 and 26, 2002, John Hoganson and Mark Gonzalez led field trips for two separate parties from Wisconsin. Hoganson worked with a group of students from the University of Wisconsin-Stevens Point on a Paleocene-age fossil site near Grassy Butte, North Dakota. The group made some remarkable finds including some well-preserved fossil flowers, a wing from a beetle, and parts of a turtle and crocodile. Another blast of winter sent the group scurrying for home a day early. A news team from KXMB-TV followed Hoganson's party in the field and broadcast a three-part news series on May 7, 8, and 9. Gonzalez led a group of geomorphology students from the University of Wisconsin—Eau Claire on a field trip through the Little Missouri Badlands to study stream processes and features. The group from Eau Claire arrived at Cottonwood Campground in the South Unit of Theodore Roosevelt National Park on Friday, April 25th just as a cold front pushed through the area. Snow, sleet, and rain made for a chilly night, but unlike the group from Stevens Point, the Eau Claire students toughed the elements and slogged their way through snow and slippery, wet clays. There was no news team brave enough to follow them in the field under the bitter conditions.

On March 12, 2002, Gonzalez gave a PowerPoint presentation, entitled "*Of Meteors and Meteorites*," to the North Dakota Astronomical Society in Bismarck. The presentation included slides of famous meteorites from Mars and the Moon, a discussion of how the origin of meteorites is determined, and a look at some of the more spectacular impact structures on earth created by meteoroids.

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New Faces



Computers are fickle creatures that require some know-how and attention to stay in top form. The Survey hired Jim Martel in December of 2001 as our new Data Processing Coordinator. Jim keeps track of our computer network and information technology hardware and software.

Jim hails from South Dakota. He was born in Faulkton, near Aberdeen, grew up in Deadwood, and spent his summers in Herreid, working on his grandfather's farm. He spent 23 enjoyable years in the Air Force. He says they must have been enjoyable years, because they went by quickly. He worked in various positions as a radio operator and repairman in stations such as Lajes field in the Azores, Keesler Air Force base in Biloxi, Mississippi, Hessisch Oldendorf, Germany, Cheyenne, Wyoming, Hofn Air Station, Iceland, and Minot Air Force Base, where he served for his last 13 years of service. After retiring from the Air Force, Jim moved to Bismarck. He recently completed a Bachelor of Science degree in Computer Information Systems through the University of Mary. Thanks to Jim's attention to details, our computer system is operating better than ever.

Jim is an avid hunter and enjoys trap and skeet shooting—good pastimes for a Dakota native.

Four students from the Geoscience Department at North Dakota State University are working with geologists at the NDGS during the summer of 2002. Carson Rittel is working with Mark Gonzalez in a Summer Internship Program, funded by the National Science Foundation and administered by the Association of American State Geologists. Carson is a native of Bismarck and is in his senior year at NDSU. His summer work will be a part of a senior thesis, supervised by Prof. Allan Ashworth, examining the Holocene snails found in the alluvium of badlands streams. Carson and Gonzalez plan to use the snails to help decipher paleo-environmental conditions in the Little Missouri Badlands during periods when stream channels aggraded (i.e., filled in with sediment) and periods when geomorphic stability led to widespread soil formation. Some snail shells will be used in an age-dating procedure based on the amino-acid content of shells.



From left to right: Cody Jacobs, Kim Jacobs, Michele Gutenkunst, and Carson Rittel in the NDGS Lobby.

Unnamed Triceratops skull in the middle.

Michele Gutenkunst is returning for her fifth summer of work with John Hoganson and Johnathan Campbell in the paleontology lab of the Survey. Michele is a native of Bismarck and is in her senior year of studies at NDSU too. She is cataloguing and preparing specimens for display and will participate in field work throughout the summer.

Cody Jacobs is working with Tom Heck to construct a well-log database. He will be interpreting log data and picking tops of marker horizons. He too is from Bismarck. Cody has completed his junior year at NDSU, but will transfer to the University of Lincoln this fall to complete his Bachelors degree in Geology.

Kim Jacobs has been working on coal studies with Ed Murphy. She is preparing a database and calculating the cumulative thickness of coal from the surface to the top of the Pierre Shale throughout western North Dakota. Kim graduated recently from NDSU and will begin graduate studies at the University of Lincoln this fall. In preparation, she will attend "Diatom camp" in Iowa for a couple weeks this summer.

Summer interns are a welcome addition to our staff. They provide valuable assistance in our duties, and the staff have an opportunity to share their knowledge and passion of geology with these budding scientists.