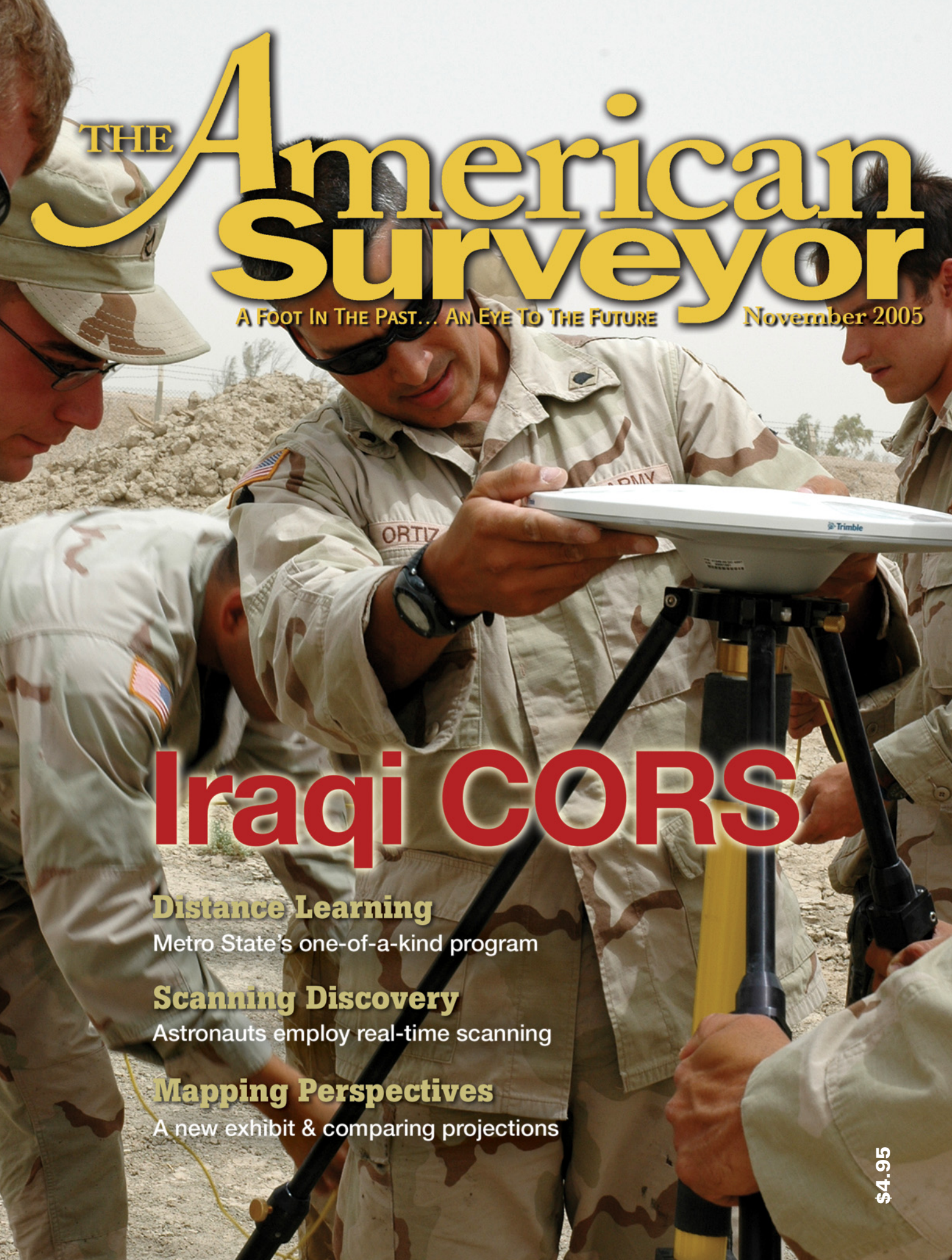
THE American Surveyor

A Foot In The Past... An Eye To The Future

November 2005



Iraqi CORS

Distance Learning

Metro State's one-of-a-kind program

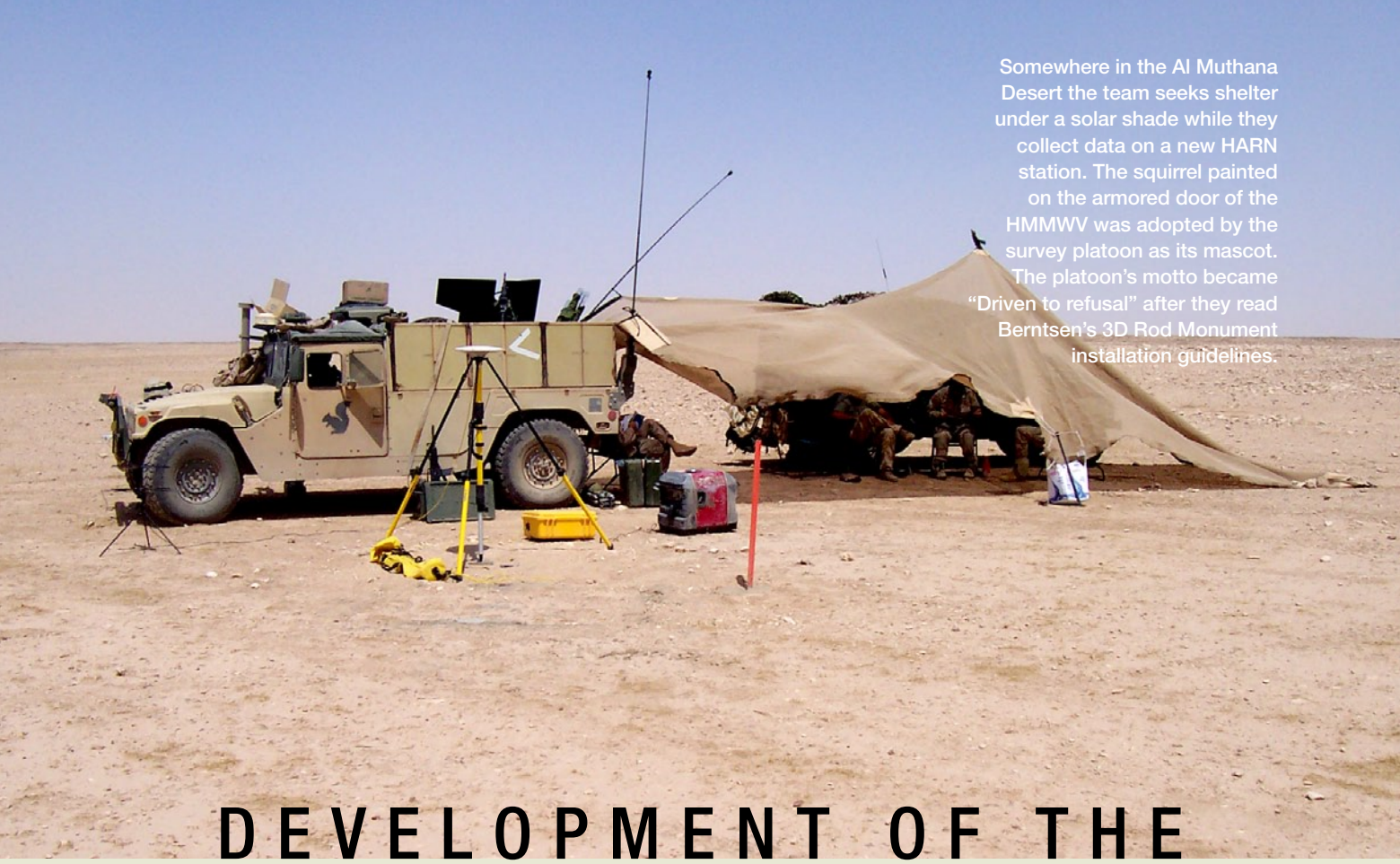
Scanning Discovery

Astronauts employ real-time scanning

Mapping Perspectives

A new exhibit & comparing projections

$4.95



Somewhere in the Al Muthana Desert the team seeks shelter under a solar shade while they collect data on a new HARN station. The squirrel painted on the armored door of the HMMWV was adopted by the survey platoon as its mascot. The platoon's motto became "Driven to refusal" after they read Berntsen's 3D Rod Monument installation guidelines.

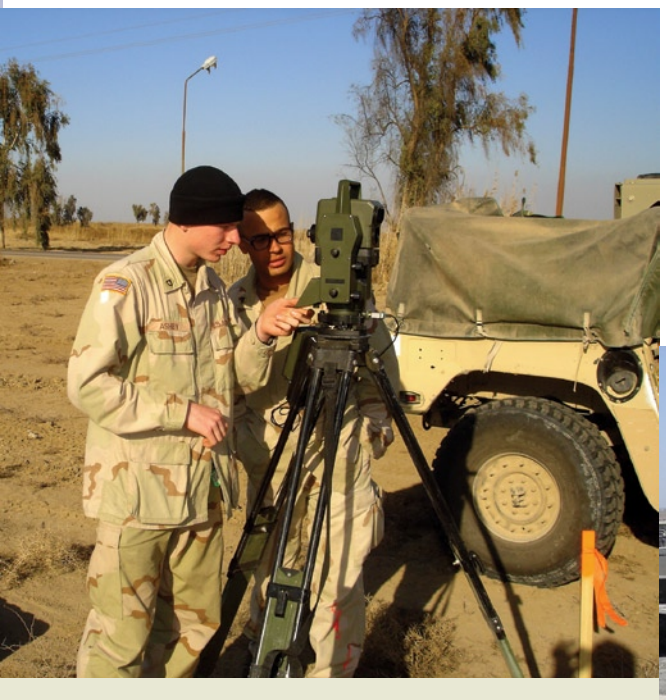
DEVELOPMENT OF THE IRAQI GEOSPATIAL REFERENCE SYSTEM

A critical component of national infrastructure, which is often taken for granted in highly developed nations such as the United States, is an accurate spatial reference system. That is, a reliable network of permanent survey marks that have established horizontal coordinates and/or elevations which are referenced to a defined coordinate system. These survey control stations form the basis of a nation's GIS databases, navigation systems, cadastral records, horizontal and vertical construction surveys, and resource management programs.

Control networks are still an essential component to the complicated science of positioning objects on, above, and below Earth's surface. But, you may ask, didn't we solve that *problem* with GPS? Simply, no. GPS has greatly enhanced the capabilities of a land-survey crew, but GPS alone is not accurate or reliable enough to support the multitude of projects which require positioning at levels sub-meter and below. GPS and conventional surveys must be based on an accurate set of reference stations in order to, for example, lay out a bridge that successfully joins in the middle or position a runway on which planes conduct precision approaches.

The United States Army 175th Engineer Company (Topographic)(Airborne Corps) arrived in Baghdad in December 2004 with the mission to provide geospatial engineer support including terrain analysis, geodetic survey, and map production to Operation Iraqi Freedom. While preparing for their first mission in Iraq, an aeronautical survey at Baghdad International Airport, the 175th survey section discovered that Iraq did not have an established spatial reference system. Further research uncovered the fact that data from previous British (circa 1917) and Polish (circa 1975) control surveys was available for some parts of Iraq; however, the historic surveys were performed to satisfy separate project requirements, and the segregated survey networks were not joined to form a continuous network that would benefit the nation at large.

Our analysis and reconnaissance determined that the historic Iraqi control surveys were plagued with problems common



SGT Mostafa gives SPC "Ash-bizzle" Ashby more on-the-job-training on the AISI.

Showing my true lieutenant-ness I (1LT Joyce) forgot my good lensatic compass, so I am using the compass on my watch to align the CORS antenna at IZTL. The bulls-eye-level that is on the wall was given to us by NGS to level the antenna mounts which were manufactured by Dave Crump of NGS. The building looked like it had solid concrete walls, but they were really very porous, which the locals told us was to provide insulation. That made it difficult to install the antenna mount as all of the epoxy SSG Evans poured into the holes we drilled was slurped up by gaps in the wall. That was a long day.

>> By COL Mark W. Yenter, LTC Tedd A. Wheeler, CPT Juan R. Mejia, Michael Cline, and 1LT Kenneth R. Joyce

among pre-GPS networks. Namely, survey data was scattered and difficult to locate, and the historic stations with established elevations did not have accurate horizontal positions and vice versa. In addition, many survey markers had been destroyed or were otherwise impossible to locate. These shortcomings were cumulative and made the existing geodetic networks generally useless to a modern surveyor.

Rather than allow this deficiency to limit geodetic survey operations in Iraq, we chose to use it as a justification to greatly increase our surveyors' influence on the War on Terrorism and reconstruction of Iraq. We boldly decided to take the leading role in developing a modern, GPS-based geodetic control network throughout the country called the Iraqi Geospatial Reference System (IGRS).

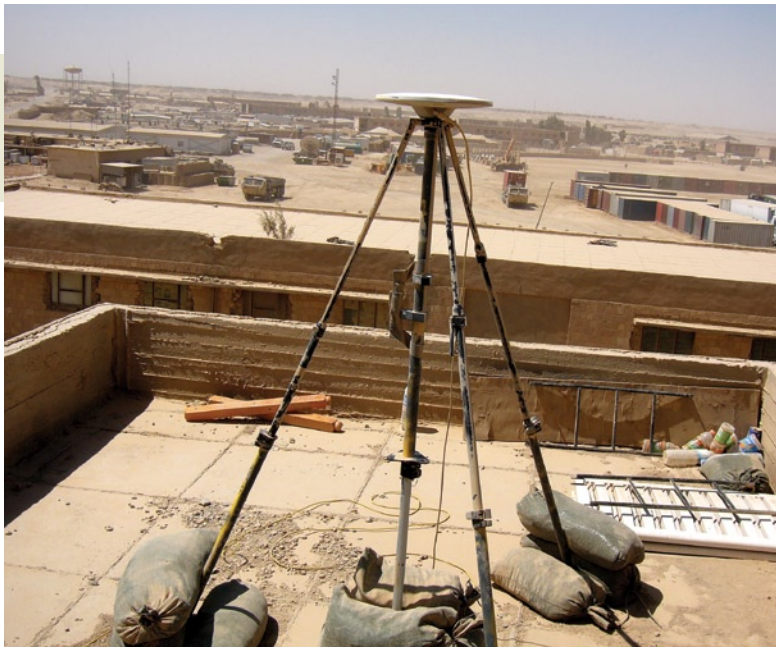
With great amounts of technical guidance from the U.S. National Geodetic Survey (NGS), we engineered IGRS in the likeness of the National Spatial Reference System (NSRS), which is developed and maintained by NGS. Most developed nations maintain similar GPS-based reference systems.

To purchase the equipment and supplies IGRS will require, the 175th applied for approximately $400,000 of contingency funds from the U.S. military's Joint Acquisition Review Board (JARB). The JARB unanimously approved the entire budget for IGRS in February. Contingency funds or "war-money" is paying for IGRS because the military manages the program's equipment and will at least initially perform all of the surveys. Alternatively, Iraqi reconstruction funds are controlled and approved by a separate authority because those funds pay for projects undertaken by multi-national civilian contractors.

CORS Network

The foundation of IGRS is a series of six GPS Continuously Operating Reference Stations (CORS) which are spread geographically throughout the country. The CORS network supports post-processed differential GPS (DGPS) positioning in all regions of Iraq. Given a complete CORS network, a survey crew working to position critical infrastructure features in Tikrit, for example, could conduct their survey using

This is a survey of a USMC Artillery Master Station in Al Anbar Province. SGT Anderson led his team to survey control points, artillery pieces, artillery radar sites, and aiming stakes throughout the province. Originally, the USMC "surveyed" these items with hand-held GPS systems, or map-spotted them. Once SGT Anderson completed his surveys, the artillery became much more accurate.

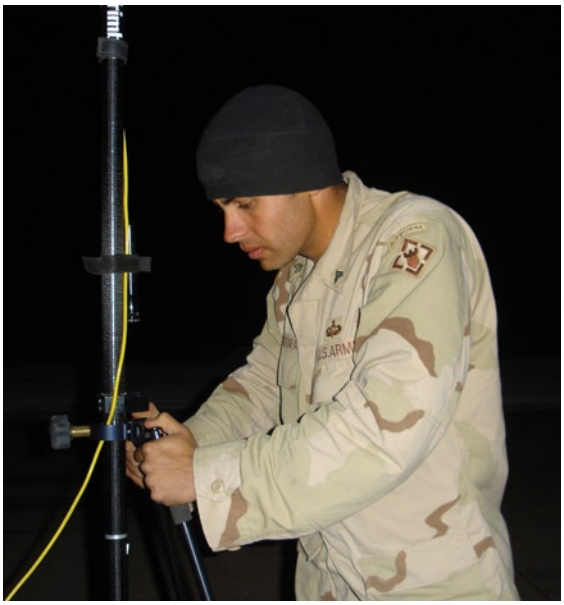


autonomous accuracies of 3 to 10 meters horizontal, 10 to 15 meters vertical. Then, the crew could download appropriate CORS data from stations in Baghdad, Mosul, and Al Asad and use it to differentially correct the field data to obtain centimeter-level accuracies for the final product. This dramatic increase in accuracy is extremely valuable and often essential to both military GPS applications such as mine clearing and remote sensing and civil GPS projects including road construction and precision agriculture.

Each CORS site consists of a Trimble NetRS dual-frequency survey-grade GPS receiver that has a permanently mounted antenna and logs position and time data 24 hours every day. Solar panels and large batteries provide the stations with uninterruptible power to ensure the receivers never fail to record an epoch of data. The stations are located at secure installations, and their data transmits over Internet Protocol (IP) to a server in Baghdad. Trimble's GPS Net software controls the server which stores and compresses the incoming data, then sends it over File Transfer Protocol (FTP) to NGS for analysis and publication. The dataset is also transferred to the public archives of the International GPS Service (IGS), a global network of geodetic reference GPS and GLONASS (a Russian satellite positioning constellation) reference stations formed by the voluntary cooperation of many worldwide agencies, including NGS. The pooled IGS dataset and its analysis products are widely utilized for global and regional geoscience and applications, and obviate the need for regional investigators to deploy their own global reference networks.

Because their purpose is to be used as reference stations for precise applications, CORS themselves must have positions that are virtually free of error. NGS calculates the positions and velocities of the Iraqi CORS by processing data from each new station with data from a set of "hub" stations that are part of the existing global CORS network. Sites having a long history of reliable operation as well as accurately measured plate tectonic velocities are candidates for hub sites. Chosen stations for the positioning of Iraqi CORS include BAHR (Manama, Bahrain), GLSV (Kiev, Ukraine), KIT3 (Kitab, Uzbekistan), LHAS (Lhasa, China), MALI (Malindi, Kenya), MATE (Matera, Italy), NICO (Nicosia, Cyprus), POL2 (Bishkek, Kyrghysstan), TRAB (Trabzon, Turkey), and URUM (Urumqi, China).

NGS processes the positions of new CORS with their custom-developed software PAGES. This program uses the



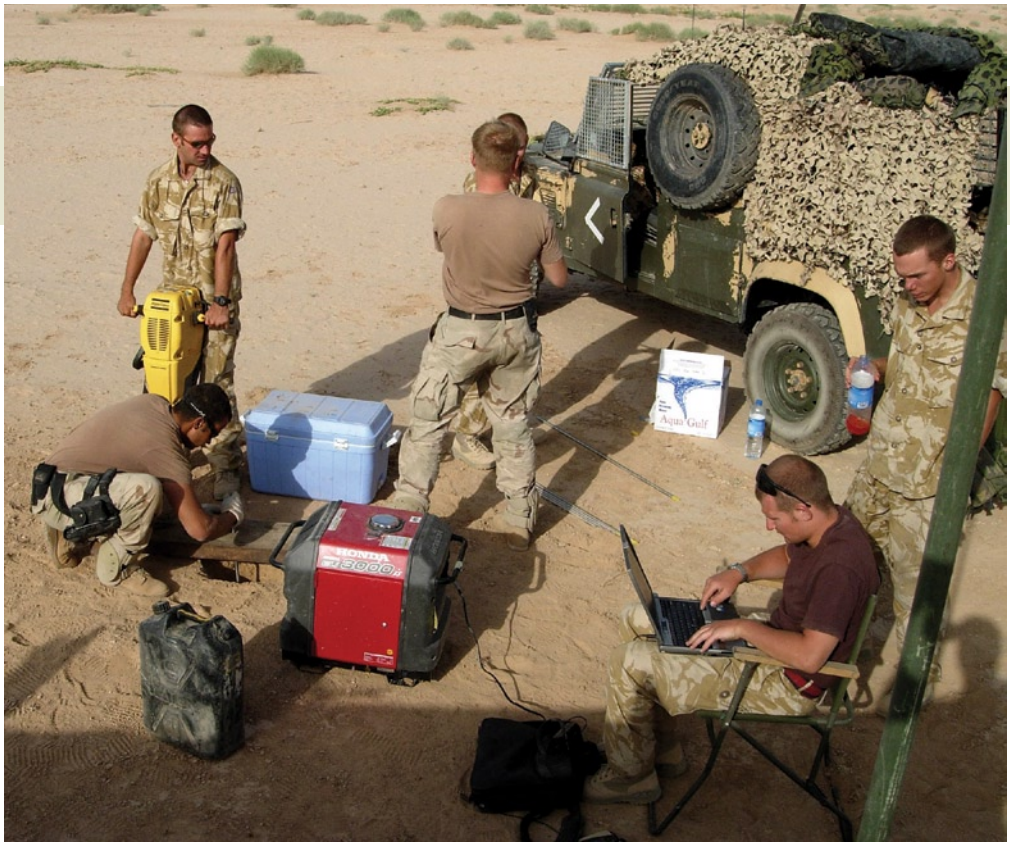
SGT Mostafa practices using the Trimble 5700 RTK system to survey a runway profile at Baghdad International Airport (BIAP). The correction is broadcasted from a base-station running on the Primary Airfield Control Station (PACS) via a Trimble TRIMMARK 3 radio. This equipment was borrowed from a small Army Civil Affairs unit out of Fort Bragg that intended to use the gear to collect data on Civil Affairs projects around the world. (Great stuff, don't let them know we still have it.)

A Harris PRC 117 radio, being used in TACSAT (Tactical Satellite Communication) mode. All six field teams used the radios to communicate via either voice or text with each other, the ops survey center, and with our company's Tactical Operations Center in Baghdad. They were also used to send GPS observation files for instantaneous processing and feedback. The range is basically unlimited, but the radios must be stationary to communicate. These radios were our single greatest asset when surveying in the desert and proved their worth time and time again. In this photo SGT Mostafa and SPC Chambers use TACSAT to radio in to the survey center after their vehicle broke down. The officer working at the survey center redirected another team in the area to the breakdown site to provide security and assistance. The two teams repaired the vehicle, and the survey drove on.

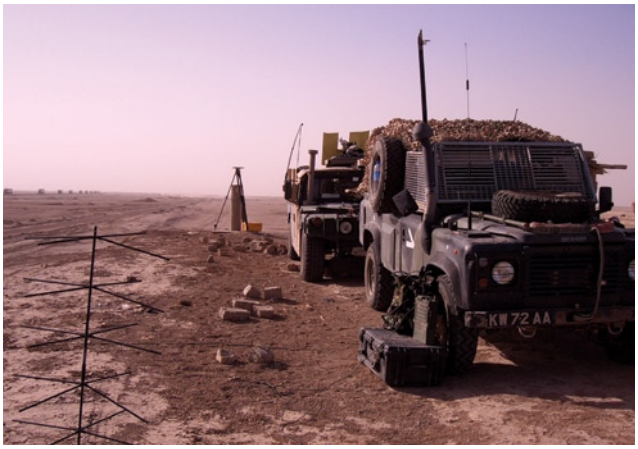
method of *double differences* to remove clock errors in GPS satellites and the hub stations. Once synchronized time is established, the precise locations of the satellites along their arcs of orbit may be calculated epoch by epoch. The positions of the Iraqi stations are then determined through triangulation to the solved locations of the satellites. For this triangulation, the software forms the L3 or ionospheric-free observable from the L1 and L2 carrier phases which are broadcast by the satellites. Measurements from a minimum of four satellites are necessary at each epoch of triangulation to solve the four unknowns of X, Y, Z position and time.

GPS satellites circle the earth's center of mass; therefore, their locations in space, and the resulting triangulation of points on the earth, are determined in an X, Y, Z Cartesian coordinate system whose origin is located at the earth's center of mass. Because site coordinates are determined in the reference frame of the GPS orbits, the mathematical Earth-model for satellite orbit calculation is all important, including the slow rate of drift of the earth's tectonic plates and of all the features embedded on those plates, such as CORS antennas. Through the continuous accumulation of daily coordinates for a worldwide collection of GPS trackers similar to CORS, plus other technological advances, Earth scientists are able to refine and refine again the International Terrestrial Reference System (ITRS), leading to the creation of International Terrestrial Reference Frames ITRF92, ITRF94, ITRF96, ITRF97, and ITRF00. Similarly, the World Geodetic System 1984 (WGS 84), or the satellite reference frame manifested as orbits that are broadcast in real-time by the GPS satellites themselves, has undergone four revisions.

ITRF coordinates are published for some common date of definition, usually EPOCH 1997.0, representing January 1, 1997, and the positions are then projected to any time of interest by means of a site's plate tectonic velocity that, barring sudden displacements from earthquakes, is well represented as a constant, linear velocity. The Horizontal Time Dependent Positioning (HTDP) model, which mathematically predicts the drift of tectonic plates, is a more detailed and feature-rich product for sites in the continental U.S. than the generalized



SGT Mostafa and crew prepare the monument at HARN MU 19. The Honda generators were quiet, efficient, and unstoppable—everything that a military generator is not. The generator powered the electric grinder, the radio, and the laptop. Each team carried a Dell laptop which was used to create the Control Point Record and interface with the TACSAT radio to send text and data files to the survey center.



SGT Ruepong's team surveys a HARN station in Al Muthana. They recovered this old concrete pillar (probably placed by a British survey crew circa 1915) and repositioned it as part of the HARN. A British Land Rover sits in front of a larger and more fuel-thirsty American HMMWV. The antenna in the front left goes to the PRC 177 TACSAT.

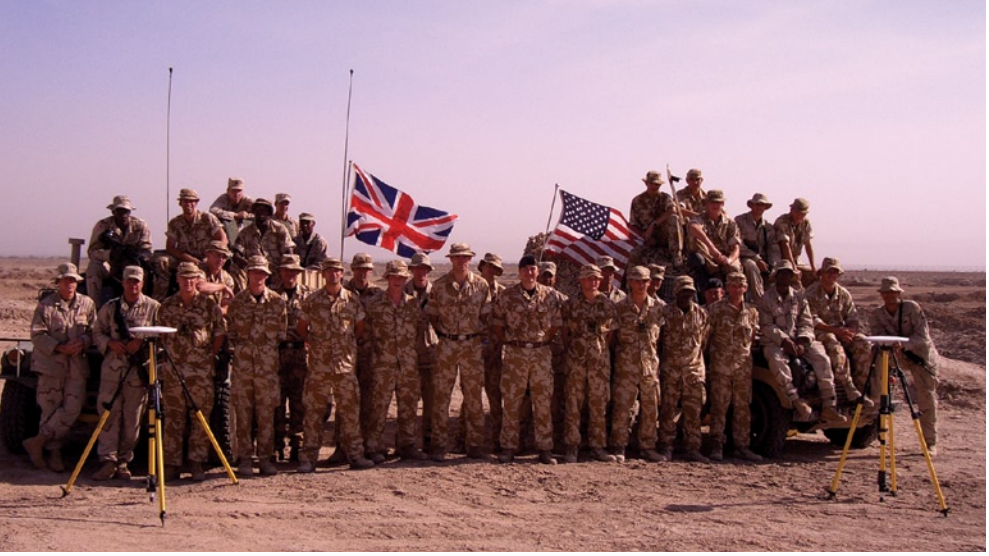
global plate tectonic model, which is known as NNR-NUVEL-1A. Developed by DeMets et al in 1994, the NNR-NUVEL-1A model is perhaps the most well-known model that may be used to predict horizontal plate tectonic velocities for locations outside the United States, usually with an accuracy of a few millimeters per year for locations within stable plate interiors. However, this model does not make allowance for *deformable plate boundaries*, such as the boundary between the Eurasian Plate and the Arabian Plate upon which Iraq lies. Predicted velocities for CORS in Iraq developed from any plate-tectonic model are expected therefore to be relatively inaccurate, requiring revisions of coordinates every few years until an accurate velocity can be calculated from the accumulated record of data.

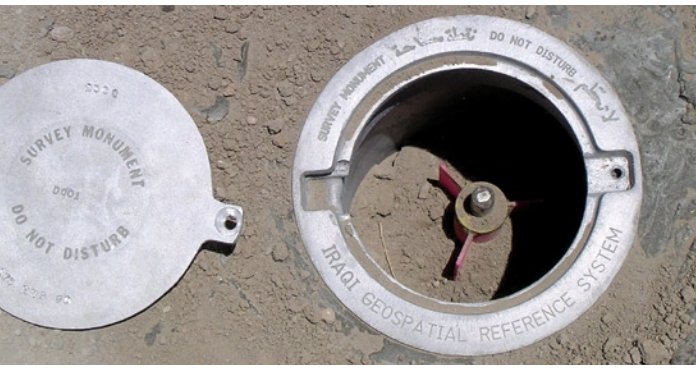
Whether a surveyor chooses to ignore or include the contribution of plate tectonics to site coordinates depends on the duration and accuracy requirements of the application. Nonetheless, the development of accurate site velocities remains the Holy Grail of coordinate computations and reference frame definition; therefore, data generated about the Arabian tectonic plate may prove to be a valuable, long-term benefit of the Iraqi CORS network.

Iraqi CORS data is available publicly through NGS at *www.ngs.noaa.gov* and IGS at *http://igscb.jpl.nasa.gov.*

HARN

The shortcoming of even the most reliable and accurate CORS network is its inability to provide starting control for conventional surveys such as level-lines and traverses. Also, CORS stations only provide service so long as they are operational. To aid Iraq in the development of a complete spatial reference





Group at Basrah Air Station after the training month and before the survey began. Ironically, the American HMMWV in the photo did a great job of flying the Union Jack while the British Land Rover let the Stars and Stripes dangle into the crowd.

This is the Berntsen monument at HARN Station DQ01. We opted for a very simple naming convention. DQ is for the province (Dhi Qar) where the station is located, and the number is just a serial in the order that stations were installed.

system that would support all types of surveys and would not be completely reliant on Iraq's only modestly reliable power systems and internet communications, we designed a nationwide High Accuracy Reference Network (HARN) of permanently monumented survey control stations.

The proposed Iraqi HARN is similar to the 1st Order survey control network component of the NSRS that covers the United States. The American network has provided invaluable service since its origins which can be traced to the Survey of the Coast in 1816.

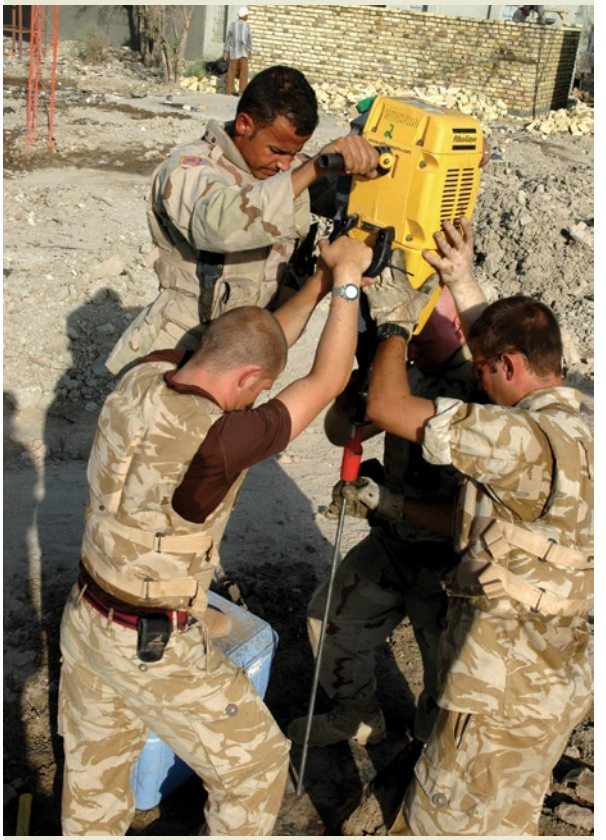
Our goal is to achieve a station spacing of not more than 50 km, which will equal a total network of 200-300 stations. Each HARN station consists of a Berntsen 9/16" stainless-steel rod monument driven to refusal with a jack-hammer and delineated with a custom access cover and witness post. We chose 3D rod monuments because they maintain superior horizontal and vertical stability in Iraq's soil, and their construction requires less concrete, labor, and most importantly time than pillar-style monuments. The points will be surveyed with static DGPS for durations determined by each station's distance from the nearest active control station (either an established HARN running a simultaneous GPS session or an Iraqi CORS). By employing flexible session schedules, the HARN teams will maximize efficiency and reduce security requirements while maintaining a homogeneous accuracy rating throughout the network.

While the previously mentioned historic surveys were referenced to a local datum (Iraqi Datum) or a regional datum (European Datum of 1950), all HARN positions are referenced to the ITRF00 using the Geodetic Reference System 1980 (GRS80) ellipsoid. ITRF00 is considered virtually identical to the WGS 84 (G1150) coordinate system as defined in 2001 by the National Imagery and Mapping Agency (NIMA), now the National Geospatial-Intelligence Agency (NGA). This seemingly arbitrary decision to use a global datum is of critical importance to the success of follow-on applications such as border surveys and aeronautical surveys which rely on the agreement of survey data over large geographic distances.

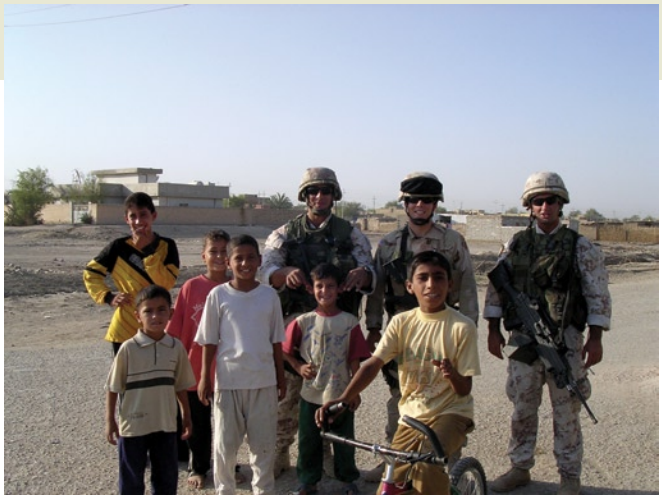
Following that argument, the third dimension of a GPS position, which is called an *ellipsoid height*, is simply the vertical distance between a given point and the WGS 84 ellipsoid. This measurement is not to be confused with an *elevation*, which is the vertical distance between a point and the *Geoid*–the equipotential surface that represents global mean sea level (MSL). Because MSL elevations are the traditionally accepted vertical measurement, GPS-derived ellipsoid heights on all HARN stations must be converted to elevations. Here we had a bit of luck; oil exploration in Iraq has produced large amounts of accurate gravity measurements. NGA uses gravity data, including the dataset available for Iraq, to develop ellipsoid height-to-elevation conversions in the form of gravity models. All Iraqi HARN elevations are determined using NGA's Earth Gravity Model 1996 (EGM 96), which is currently the most accurate model for the region.

Aside from the project's various technical hurdles, developing the Iraqi HARN presents a formidable logistical operation. The field teams require constant re-supply and protection in order to survive and complete their missions while spread throughout a desert that is extremely hostile. Because the 175th is a technically oriented engineering unit and possesses limited organic resources such as manpower, force-protection,

SGT Mostafa and Sappers Scally and Schirn hoist a Cobra Combi onto a rod to drive it into the ground. This station is located in a urban environment, where the risk of insurgent attack is much grater than in the open desert. SGT Mostafa assessed the increased risk and demanded that his troops remain wearing body-armor throughout this installation. The team leaders were constantly forced to compromise between the threat of a soldier overheating and the threat of enemy attack.



The IGRS fleet consisted of HMMWVs, Land Rovers, Bedford trucks, and Medium Tactical Vehicles (MTVs). Up to four mechanics were attached to the team at any time to keep these beasts running.



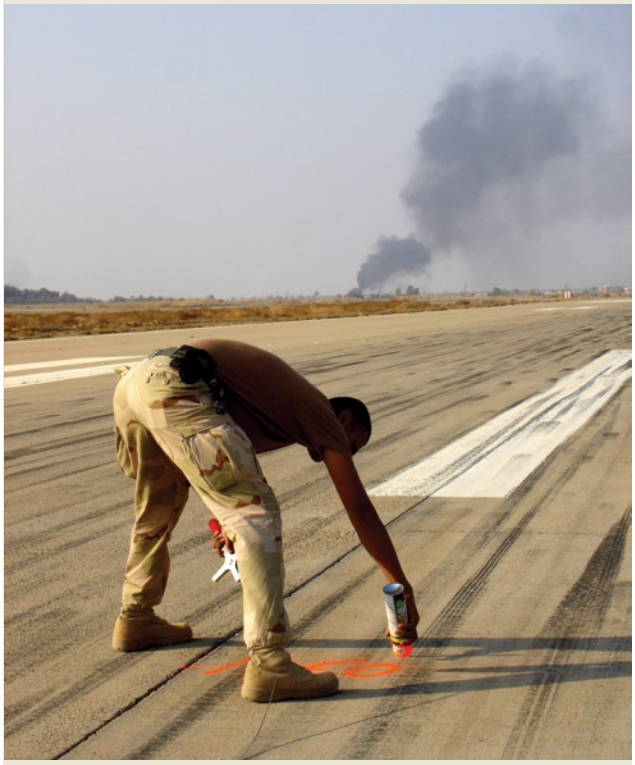
1LT Joyce with the Italian escorts and a group of Iraqi children in Nasariya. By the time they installed the monument at this site, there were about 60 kids hanging around.

SPC Chambers prepares to put another steel rod section onto the monument the crew is driving into the ground. The access cover and 6-inch PVC pipe are leaning against the wall. The Iraqi man in the photo stared at us like we were crazy. Following adventures like this one, the British Psychological Operations (PSYOPS) printed Arabic information pamphlets for the surveyors to hand to civilians around job sites. We are not sure what the pamphlets said, but they seemed to satisfy the locals.

and logistics support, our initial analysis determined that the feasibility of the mission was bleak. Again, a shortcoming became an opportunity. To meet the mission requirements, we augmented the unit's manpower and expertise by partnering with the 42nd Engineer Regiment (Geographic), British Royal Engineers. We found this outstanding group of "mates" in Basrah, and their infectious enthusiasm has provided IGRS ample fuel since the day we sat together and developed the project's initial plans.

Presently, after a month of intense technical and tactical training, the combined group of American and British surveyors is breaking into six autonomous teams to survey the first phase of the HARN which covers Iraq's four southern provinces: Muthana, Dhi Qar, Maysan, and Basrah. Each field team is lead by a British or American non-commissioned officer who is responsible for all aspects of his team's safety and prosperity as well as the completion of technical tasks involved in the survey. The IGRS Operations Cell, which is located on Basrah Air-Station, will synchronize the survey plans and coordinate the taskforce's movements and logistics support.

To monitor data integrity, the teams will send survey data from each job site to Baghdad using satellite radios. A quick computation at this central location will determine the validity of the data and provide nearly instantaneous feedback to the field crew. This added process will greatly diminish the number of sites that must be revisited to rerun failed GPS observations.



SGT Ruepong marks a runway at BIAP in preparation for the runway profile survey. We hate doing something twice, so we generally mark and survey the runway every hundred feet then throw out any data that the specs don't require us to publish. For us, an airfield survey is a big job. This crew had 12 surveyors between the office and the field. We will plan four weeks for a big airfield like BIAP, but generally we can get the job done in two as long as we are resourced and nothing goes wrong.

The HARN task force will publish the entire data set including station coordinates, elevations, photographs, and descriptions on an interactive web page. The web-interface will provide all reconstruction engineers and surveyors in Iraq easy access to accurate and updated HARN data.

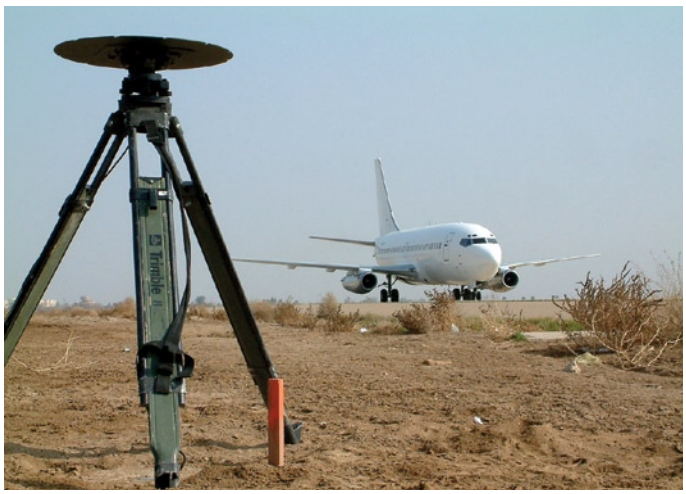
Outlook

The final and possibly most valuable stage in the development of IGRS is the training and integration of Iraqi surveyors into the HARN field teams and the CORS management cell. Considering that goal comes to fruition, in addition to providing support for civil-military construction projects, IGRS could be a powerful catalyst in the reestablishment of a federal Iraqi mapping and survey agency. The engineer staff section of the Multi National Corps Iraq, referred to as MNC-I C7, has made contact with several ministries within the new Iraqi government that are considering the creation of a sub-agency which could take over national geospatial engineering including the management of IGRS. A transition from C7 to Iraqi management will ensure the continued development and use of the survey networks throughout reconstruction and into Iraq's future.

Beyond Iraq's borders, many other developing nations still require assistance in establishing modern spatial reference systems. For instance, through progressive outreach programs NGS has provided equipment and expertise in Central and South America, the Caribbean, Africa, and Eastern Europe to nations that are establishing CORS and HARNs. These efforts have proven particularly effective in nations recovering from natural disasters such as hurricanes and earthquakes. War-torn countries require the same geospatial reconstruction; however, military engineering units are more able than civilian agencies to provide support in these regions that generally suffer from decreased security manifested in widespread violence and criminal activity.

Air traffic is heavy at BIAP, so SGT Oneal and teammate are running with steel tape to measure and mark a runway in the short period of time the tower gave them. Something is always burning in Iraq; you can see the large pillar of smoke rising in the distance.

BIAP is a very busy airport. Here you see the crew's equipment set up for a static GPS session while a cargo plane taxis in the backdrop. The surveyors' first mission in Iraq was to survey BIAP to the National Geospatial Intelligence Agency (NGA) TAGGS standard. Later the platoon completed a survey of Udari Army Airfield, Kuwait to the FAA 405 standard. Our surveyors are well versed in surveying airfields and drafting obstruction charts for NGA and the Army. The British surveyors also do airfield surveys for NGA; they did a survey of Basrah Air Station in 2004.



UNCLASSIFIED \ LIMDIS

IRAQI GEOSPATIAL REFERENCE SYSTEM

IRAQI GEOSPATIAL REFERENCE SYSTEM

MULTI-NATIONAL FORCE-IRAQ

LEGEND

CONTINUOUSLY OPERATING REFERENCE STATIONS
- 4 OVERLAPPING BUFFER
- 3 OVERLAPPING BUFFER
- 2 OVERLAPPING BUFFER
- 200 KILOMETER BUFFER FROM IZTL
- 200 KILOMETER BUFFER FROM IZAD
- 200 KILOMETER BUFFER FROM IZBD
- 200 KILOMETER BUFFER FROM IZBA
- 200 KILOMETER BUFFER FROM IZOW

HIGH ACCURACY REFERENCE NETWORK
- HARN
- PROVINCE
- IRAQ BORDER

FOR MORE INFORMATION:
CORS DATA:
WWW.NGS.NOAA.GOV/CORS
HARN TRIANGULATION LIST:
MNC-I-01-GEO-OR
S1, 30TH ENGINEER BATTALION

Prepared and published by the
175th Engineer Company
30th Engineer Battalion

MULTI-NATIONAL FORCE • MULTI-NATIONAL CORPS • IRAQ

SCALE 1:1,200,000

PROJECTION ..... GEO LAT/LONG
DATUM ..... WGS 84
SPHEROID ..... WGS 84

CAUTION: FOR PLANNING PURPOSES ONLY. NOT TO BE USED FOR TARGETING OR NAVIGATION. INFORMATION DERIVED FROM NGA (NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY) SOURCES AND HAS NOT BEEN FIELD CHECKED FOR ACCURACY.

20TH ENGINEER BRIGADE

COL	MARK	TENTER	SGT	DANIEL	RUBPONG	SPC	KEVIN	MINCHEW	SPC	TRAVAN	JOHNSON
LTC	TEDD	WHEELER	SGT	MOTAZ	MOSTAFA	SPC	PARKER	ASHBY	SPC	JUSTIN	STAFFORD
CPT	JUAN	MEJIA	SGT	CHRISTOPHER	ONEAL	SPC	LUCAS	ORTIZ	PFC	NICHOLAS	LAWTON
1LT	KENNETH	JOYCE	SGT	CARLOS	RENDON	SPC	RANDALL	COX	PFC	BLAKE	CHAMBERS
1LT	DANIEL	WILLIAMS	SGT	TAURIEN	THOMPSON	SPC	COLIN	WILLIAMS	PFC	BLAKE	OVERBAY
CW2	TODD	POLLARD	SGT	JEREMY	NICKEL	SPC	FRANCIS	ENGLISH	PFC	JAMAL	JOSEPH
SSG	MICHAEL	MORRISON	SGT	HEATH	ANDERSON	SPC	BRYON	HUNT			
SSG	BENJAMIN	EVANS	SGT	DONALD	MACK	SPC	WARREN	BROUGH			
SSG	BRYAN	STURGEVANT	SGT	ERICA	BLAKE	SPC	JASON	KAMPROWSKI			
SGT	DONALD	BOK	CPL	JOSHUA	HUNLEY	SPC	CADE	WEBSTER			

42 ENGINEER REGIMENT (GEO)

CPT	MICKI	EINHAM	LCPL	CHRIS	CLARK	SPR	DUNCAN	LOCKHART
CPT	PAUL	HAMMETT	LCPL	STUART	KEMPSTER	SPR	MALCOLM	RIMMER
LT	SIMON	HALL	LCPL	PAUL	MURPHY	SPR	WAYNE	HUDSON
SSGT	SIMON	NEW	LCPL	ROSS	COLWELL	SPR	DAVID	SCHIRN
CPL	STUART	RIGGOTT	LCPL	LEE	HURSH	SPR	MARK	SADDLER
CPL	STEVE	ELLIS	LCPL	STEVE	AVIS	SPR	RICHARD	COOK
LCPL	NEIL	DICKEN	SPR	LUTHAN	WILLEY	SPR	CHRIS	ANTOINE
LCPL	TRISTAN	COWARD	SPR	ANDREW	MOREY			
LCPL	KEITH	HARRIS-HUGHES	SPR	DAVID	THOMAS			

HALLIBURTON
JAN NOPPEN KBR

TAMSCO
WILLIAM FLESHOOD TAMSCO

Berntsen Survey Markers
BRENDA BURDINE BERNTSEN
CLAUDIA FULLER BERNTSEN

BARY LOWE SEAME
HOCHEY MCDONALD SSMCE

The Society of SAME American Military Engineers
CAROL BOWERS SAME
BILLEN BRICKSON SAME

44TH MEDCOM

SGT	JOSEPH	AVERY
SGT	QUENTIN	MARTIN
SPC	EBONY	DUKES
PFC	DEREK	VAN TUYL
PFC	JAMES	WARE
PFC	ANTHONY	SANDERS

NATIONAL GEODETIC SURVEY

DAVE	DOYLE	NGS
MIKE	CLINE	NGS
DAVE	CRUMP	NGS
MIRANDA	CHIN	NGS
GIOVANNI	SELLA	NGS
JOE	EVJEN	NGS
RICHARD	SNAY	NGS

ERIC WERNER NGA

GARY THOMPSON NCGS

BLAKE HENDERSON OGE
C.J. WOLFE OGE

Trimble
DAVE NEWCOMBER TRIMBLE
JACK PATTON TRIMBLE
DENNIS BELGRADO TRIMBLE

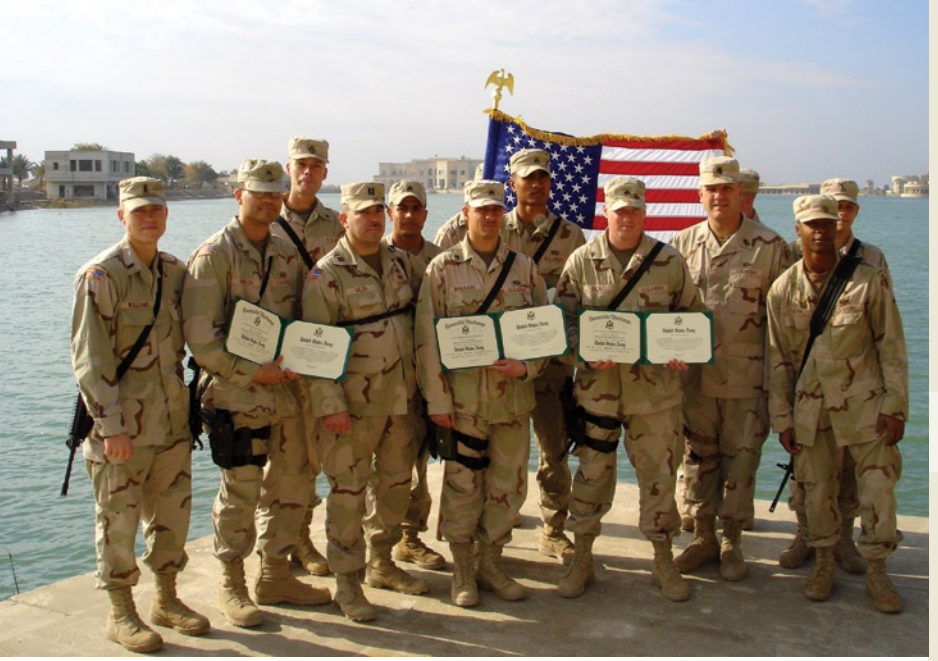
NORTHROP GRUMMAN
STUART RAINS NG
DAVID ULMER NG

The American Surveyor
MARC CHEVES TAS

IGS
PHILLIN MOORE IGS
CAREY NOLL CDDS

GEA CORPORATE SPONSOR

UNCLASSIFIED \ LIMDIS



Three surveyors—SGT Bick, SGT Rendon, and SGT Malkawi—reenlist outside of the company headquarters located on Al Faw Palace Lake.

By using IGRS as a model to create similar programs in nations like Afghanistan and Somalia, the army could effectively package what NGS developed as a successful multi-nation technical assistance program into a military reconstruction effort. Thus, army engineers will further enable nations emerging from conflict to face the daunting task of rebuilding large portions of their infrastructure.

Author Note: We would like to express our most sincere gratitude for the assistance provided by Dave Doyle of NGS and Angelyn Moore of IGS. Their technical advice and experience in the field of geodesy were extremely beneficial to this article and essential to the success of the IGRS project.

Colonel Mark W. Yenter is the Brigade Commander of the 20th Engineer Brigade (Combat)(Airborne Corps) and Director of the Multi-National Corps Iraq, Staff Engineer Section. He holds a BS in Civil Engineering from the University of Colorado and a MA in National Security and Strategic Studies from the Naval War College. COL Yenter is a licensed Professional Engineer in the Commonwealth of Virginia.

Lieutenant Colonel Tedd A. Wheeler is the Battalion Commander of the 30th Engineer Battalion (Topographic) (Theater Army) and the senior Iraqi Theater Geospatial Engineer. He holds a MS in Construction from Arizona State University and a Masters of Military Arts and Sciences from the School for Advance Military Studies at Fort Leavenworth, KS.

Captain Juan R. Mejia is the Company Commander of the 175th Engineer Company (Topographic)(Airborne Corps). He holds a BS in Construction Technology from Purdue School of Engineering and Technology and a MS in Engineering Management from the University of Missouri-Rolla.

Michael Cline is a Geodesist with the National Geodetic Survey, Silver Spring, Maryland.

First Lieutenant Kenneth R. Joyce is the Executive Officer of the 175th Engineer Company (Topographic)(Airborne Corps) and Project Manager of the Iraqi Geospatial Reference System. He holds a BA in Physics from Colorado College.

Post Script from 1LT Joyce, August 25, 2005:

We have reached two major milestones in the development of the Iraqi Geospatial Reference System:

1st: All six Iraqi Continuously Operating Reference Stations (CORS) are now fully operational. We solved the networking issues that plagued the system, and all stations now collect and transmit data flawlessly. The compliments of this success are owed to the tireless efforts of SGT Bick, the Trimble technical support staff, and network administrators at the Corps of Engineers and ITT.

2nd: We have completed data collection for the High Accuracy Reference Network (HARN) in southern Iraq. The joint U.S. and British survey teams under 1LT Williams and SSG Morrison (US), and LT Hall and SSGT New (UK), installed 64 Berntsen 3D Rod monuments, and they collected extensive data with Trimble 5700 GPS receivers on each point. We are now processing the data by using and comparing solutions from the National Geodetic Survey (NGS) Online Positioning User Service (OPUS) and a network that the team developed in-house on Trimble Geomatics Office. So far, the data looks great; all positions are closing within a few centimeters in X, Y, and Z.

More important, word about IGRS is spreading. Army, Air Force, Marine, and civilian surveyors from many nations and disciplines are beginning to use the CORS and HARN stations for projects all around Iraq. The extreme accuracy and efficiency of the IGRS products are positively influencing the wide success of both military operations and civil reconstruction efforts.

Of additional interest, while the IGRS surveyors were operating in Dhi Qar Province a photo-journalist, Senior Airman Sloan from the Camp Victory Public Affairs Office, spent several days doing a story on them. The article she composed and pictures she took are featured on the DoD's news page and will appear in our local news bulletin this week. Please enjoy: *www.defendamerica.mil/articles/aug2005/a081505la1.html*

1LT Joyce, IGRS Project Manager