

THE American Surveyor

A FOOT IN THE PAST... AN EYE TO THE FUTURE

May 2006

Island Network



GPS, GIS & the GLO

Exposing old errors in Wisconsin

Nantucket's Compass Stones

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Surveying in the South Pacific

The South Pacific. Think palm trees, sandy island beaches and warm turquoise waters. Add to those a vibrant mining industry, a growing use

of GPS and GIS technology and you have a good picture of New Caledonia, an island country 1,500 km (932 miles) east of Australia. Consisting of the main island of New Caledonia (one of the largest in the Pacific Ocean), the archipelago of Iles Loyauté (the Loyalty Islands), and numerous small, sparsely populated islands and atolls, New Caledonia today is a unique combination of tropical island culture and advanced surveying technology.

Mining with GPS

A French overseas territory with full internal autonomy, New Caledonia is said to contain about 20 percent of the world's known nickel reserves. With world demand continuing to increase – forecasts estimate a 3-4 percent increase in demand per annum – the South Pacific

island country is currently undergoing a multi-billion dollar expansion of its nickel mining and smelting industries. GPS technology is helping make that happen.

The island's nickel deposits are relatively close to the surface – open cast – and mined using a combination of excavators, dump trucks and bulldozers. Most mines are located in the island's mountainous region in the northern province; locating and drilling the rich ore deposits depends on a unique mix of surveying tools.

Less than a decade ago, geological mapping and positioning of samples for ore exploration was done manually, using topo maps with an altimeter and compass to prospect potential nickel reserves. Today, rugged handheld GPS receivers have made the process faster, easier and much more accurate, says Paul Atkins, geological technician for the Tiebaghi Nickel Mine. The handheld GPS receivers help position the mineral samples within less than five meters, allowing more accurate relocation for the drill phase.

>> By Steve McGowan



A BGN surveyor uses a Trimble RTK GPS 5700 -TSCe system with Survey Controller to establish a control point while using a Trimble RTK correction transmitted via cell phone from Nouville's reference station under GPRS in Nouméa.



Located in Vallée du Tir (Nouméa), a permanent Trimble NetRS/ZGA with weather radome is part of the future BGN Trimble VRS infrastructure network.

NEW CALEDONIA

Divided into three provinces, North, South and the Island, New Caledonia has a land area slightly smaller than New Jersey. The Southern Province, with the capital city of Noumea, is the most densely populated, with approximately 40 percent of the land area and 68 percent of the population. The Northern Province makes up 52 percent of the land area with about 45,000 inhabitants, and holds most of the island's rich mines.

"GPS was a big evolution in positioning," said Atkins, who uses Trimble GeoExplorer GPS receivers for the exploration process. "We're able to position samples exactly – it's a major improvement from the manual process."

One of the newest mines in the Northern Province, the Tiebaghi mine pit presently covers 100 hectares but the infrastructure and future expansion are spread out over around 25 square kilometers (15.5 square miles); Eramet-SLN, which owns the



Tiebaghi mine, also holds mining permits for several thousand square kilometers across the island. The large mountainous area covered is why "GPS is so useful," says Atkins, who did exploration before managing the mine's survey tasks in his current position.

For areas that show promise, crews return for diamond drilling, a process requiring increased accuracy, especially vertically. Containing a bit embedded with diamond studs, the diamond drill cuts a cylinder sample core from the rock. After determining the sample's properties at the lab, if the area is rich in nickel deposits it is prepared for mining. And the Tiebaghi mine uses GPS throughout the mining process.

To set up a mine drilling program, Atkins uses SMG's Surpac Vision, a geological resource information system, to produce the mine's grid and horizontal 'bench' limits in the office. Using Trimble Geomatics Office software, Atkins transfers the grid into the Trimble TSC1 data controller to then stake out the mine bench limits as well as the starting vertical level for the drills. Because this phase requires greater accuracy, crews use a Trimble 5700 RTK GPS system to do the survey tasks; the system is also used daily to check the excavator's horizontal level for drainage and quality of product, Atkins said. The horizontal limits often need to be restaked if trucks have disturbed the lines.



Aerial view of Tiebaghi Mine in New Caledonia, located in the island's mountainous region in the northern province.

Once mining is underway, the Trimble 5700 is used to position the drill holes for grade control and survey the vertical level. The vertical measurement is required at the start of the drill hole to tie it in with the rest of the drill holes in Surpac. The depth enables them to know which level they're on, and how far to drill. GPS is also used to measure slopes for ramps and position limits for daily mining.

Reference Station Network

Because of their dependence on GPS, the Tiebaghi mine set up its own permanent GPS reference station in the La Grande Terre portion of the Island. Private surveyors working the plains below the mountain are also able to use the mine's reference station.

"GPS gives you more freedom to work where you want to without needing to set up base stations everywhere," said Atkins. "You can work faster and save time and money by using one person instead of a two-person crew. And you can work even when the mine is obscured by cloud covering, which happens a lot in the mountain regions. It's a big change for us."

In the future, the Tiebaghi reference station will be part of a 15-station



Top: The Tiebaghi Mine uses a Trimble 5700 RTK GPS system to stake out new mining limits; the system is also used daily to check the excavator's horizontal level for drainage and quality of product.

Bottom: Tiebaghi surveyors discuss the starting vertical location for the drill holes; the mine's grid has been uploaded into the Trimble TSC1 data collector for stakeout and drill hole purposes.

real-time kinematic (RTK) GPS infrastructure network currently being developed by the Government of the New Caledonia Bureau of Geodesy and Leveling (DITTT - Direction des Infrastructures, de la Topographie et des Transports Terrestres), section BGN (Bureau de la Géodésie-Nivellement). The BGN's goal is to cover the main

island with a Trimble VRS (Virtual Reference Station) network in order to further expand the island's GPS capabilities for mining and other applications, according to Cyrille Dumas-Pilhou, BGN Manager.

BGN is developing their VRS network for other reasons as well. "BGN desires to maintain a high level of inter-



A surveyor uses a Trimble RTK GPS 5700 with TrimMark3 UHF radio system broadcast from Nouville's reference station to collect the Topo for the expansion of a residential complex at Baie de la Moselle (Nouméa).

national technological capabilities, which means offering a RTK GPS network," said Dumas-Pilhou. "It will also set up an infrastructure that will help move the mining expansion projects forward more quickly and result in greater productivity for surveyors."

Dubbed "BANIAN" by BGN, the VRS network will include a control center running Trimble GPSNet and RTKNet software in the BGN office at Noumea, as well as an initial network of six Trimble NetRS reference stations in Yate, Goro, Tontouta and Noumea in New Caledonia's Southern Province. It is also planned to replace the current units located in Lifou and Koumac as part of the initial phase. The initial six-station network is expected to be completed by June 2006, with a full 15-station network

becoming operational in 2008. BGN expects about 50 users, mostly land surveyors, for the network.

Building a Network

BGN has been working towards an island-wide RTK GPS network for years. Since 1996, BGN has operated a permanent reference station in Noumea; the reference station is available to anyone requiring (RTK) GPS and differential GPS (DGPS) corrections via the Internet. The reference station, today a Trimble 5700 RTK GPS system, is being used for surveying, construction, mining, GIS and geophysical research applications.

"Because of our geographical location we also have people from around the world downloading our 30-second

RINEX data from the website," said Dumas-Pilhou. "In fact, now that our reference station is on the Internet we expect organizations globally to integrate the station into other networks."

In March 2004, BGN upgraded the reference station to Trimble GPSBase software, enabling BGN to serve their local area with a single reference station today and be positioned to grow towards the larger network now being implemented. In addition, General Packet Radio Service (GPRS) service was initiated on the island in 2003; testing of the reference station using GPRS was done by BGN in collaboration with Office des Postes (OPT), the only telecom provider on the island, and SYPOS, a local survey dealer. Prior to GPRS, the island mainly offered Global System for Mobile Communication (GSM) service. A packet-switched technology, GPRS is more efficient and economical for data communication use than the circuit-switched GSM technology.

"The main purpose of these tests was to prove the technology and thus take a first step towards a VRS network," said Dumas-Pilhou. "Before we developed the VRS, everything relied on the one station at Noumea and there was no redundancy. VRS technology is a new step in geodesy."

Because of the mountainous regions in New Caledonia, the use of UHF radios to transmit RTK data was never really adopted. The GPRS network is much denser and offers better coverage to the users, especially in populated areas, according to Dumas-Pilhou. "And since the cost of cell phones are less than a radio, GPRS is likely to be adopted very quickly."

With the use of GPRS, the main application for the single reference station in Noumea is DGPS across the entire island. RTK applications are today limited to within 15 km (9.3 miles) of the reference station. BGN's new Trimble VRS network will allow users with RTK GPS rovers to gain centimeter-level positioning throughout the island without investing in (or setting up) a local reference station.

In general, reference station networks require surveyors to be within approximately 15 km of one of the network base stations; anything further and the user may be vulnerable to reduced accuracy and performance due to ionospheric and tropospheric factors. With a Trimble VRS network of GPS reference stations



Overlooking a residential district in Normandie, this location provides an ideal unobstructed view for a CORS.

and software which provides a fully modeled solution, a user connects into the system using a wireless connection and the software lets the user operate as though there is a base station right next to their rover. As a result, errors related to distance are significantly reduced.

The island already has a GPS control network called the RGNC91-93, set up in 1991 by the Institut Géographique National, France (IGN); the network was densified by BGN in 1993 and today includes 220 control points throughout the island territory. Dumas-Pilhou hopes the Trimble VRS network will reduce the need to maintain the GPS monumentation in the future.

GIS Use

The network would increase productivity for GIS users as well. Today, many of the island's governmental agencies use GIS for a variety of applications, including agriculture, forestry, tourism, transportation and land and economic development.

The Northern Province set up a GIS in 2000 to provide a tool for helping make governmental decisions for the area, according to Gilles-Victor Remond, GIS administrator. Operational since 2002, the GIS covers the province with a variety of data sources including maps at 1:10000 scale, IGN raster images,

cadastral work, aerial photos, and information on pedology and geomorphology. Users create their own databases based on the existing main GIS; they may also create new databases using GPS to collect new data. Most users access the Noumea station for postprocessing, as distance is too great for RTK. The Trimble VRS network will make RTK GPS available for GIS use as well.

As one unique example, the Northern Province asked its surveyors to provide GPS location information of native Melanesian huts, which numbered between 2000-3000 in the province. Some of the traditional huts, many of which had mud walls, had been painted with tremolite, a white asbestos mineral native to the South Pacific island, for sanitary reasons in the middle of the last century. After extensive research, in 2003 tremolite was declared a health hazard. Armed with GeoExplorers,



Located in Normandie (Nouméa), this antenna (co-located with a DORIS station) is part of the future network that will include 15 RTK GPS reference stations throughout the main island.

government surveyors located each tremolite-painted hut on its GIS; data is postprocessed with the Noumea reference station. Currently, the huts are being destroyed and rebuilt by the government.

While some may think of the South Pacific only as beaches and palm trees, New Caledonia is joining the ranks of some of the most advanced technological countries with its use of GPS and GIS technology. *AS*

Steve McGowan is a freelance writer specializing in surveying.