The Continental Drift Observation Project

Simon Ritchie

For the past few years I’ve been experimenting with accurate GPS receivers. These can tell you your position very accurately. I’m not a professional surveyor, I write software for a living, but I’ve found that the equipment is very easy to use once you understand the underlying concepts. The devices been around for over twenty years but recently they’ve become cheap enough for schools and colleges to use them. They have many applications in education, but I don’t think that educators have realised their potential yet.

Although they use GPS, these devices are not SatNavs. They are surveying tools - they find and report their position to within three centimetres or better. The UK along with the rest of the Eurasian continent is moving at about 2.5 centimetres per year due to continental drift, so the equipment is accurate enough to detect and measure that effect over time. I’m proposing a project in which students of secondary school age will do just that.

Manufacturers of this equipment include Sparkfun, Emlid and Trimble. The yellow and white disc in the picture below is my Trimble Catalyst, perched on the centre of the Ordnance Survey trig point at Box Hill, with my smartphone displaying its position:

A basic GPS receiver like this costs around £300. You can buy them off the shelf or make your own. (See the reference material below.) To keep the cost down many receivers use a nearby smartphone to provide a display, signal processing and Internet access.

Just to confuse the issue with facts, GPS is nowadays called a Global Navigation Satellite System (GNSS) and there are three other networks (or "constellations") of satellites visible in the UK, the European Union's Galileo constellation, the Russian GLONASS and the Chinese BeiDou. To find its position, a GNSS device needs to see just four satellites from any or all of the constellations. The one in my garden shed can regularly see upwards of twenty satellites.

Observing Continental Drift

I propose that students at secondary school should run a long experiment by going out once a year, measuring the position of some fixed reference point using a GNSS receiver and watching it move, along with the rest of their continent. All continents are drifting so this experiment can be done on land anywhere in world. It's one thing to be taught continental drift as a theory, it's quite something else to watch it happening over your school career.

The experiment is run like so:

- At age eleven, the student uses a GNSS receiver to measure the position of a fixed reference point and records it.

- At age twelve, the student measures the position of the same point and gets a different result. By this time, the European continent will have drifted north-east by about 2.5 centimetres from the first measurement. That's just within the limit of the expected accuracy of the GNSS receiver, so the difference could be explained away as equipment noise.

- At age thirteen, another measurement. The reference point has now moved five centimetres. That's more than the error range of the equipment, so now the effect of continental drift is visible.

- By age sixteen, the reference point has moved about 12.5 centimetres and the student will see a very obvious track to the north-east.

- If the student stays on at school until they are eighteen and continues the experiment, the effect of the drift will be yet more obvious.

The reference position that the students measure can be anywhere out of doors with an open view of the sky. It could be within the school premises. A school estate will often have some fixed surveyor's marks that may be suitable, otherwise the reference position could just be a wooden stake driven securely into the ground. Consult your estate manager.

If the school has the resources for field trips, the reference point could be any accessible fixed point in the landscape. In the UK, Ordnance Survey trig points are a good choice because they are very robust and fixed firmly in place.

It's only recently become feasible for schools to do this experiment, but why do it? Subject-based teaching tends to separate out knowledge into disconnected fields. Continental drift is a fascinating phenomenon combining aspects of geography, mathematics, physics, chemistry, biology and ancient prehistory. It's one of a few phenomena that can be measured in a school project that tells us what's going on deep inside the Earth. The continents drift because underneath our feet is a maelstrom of molten gunk, heated to enormous temperatures, subject to huge pressures and being very slowly churned by convection currents. The forces that move the continents played a crucial role in the origins of life and has been responsible for extreme climate change.

On a practical level, measuring continental drift gets the students used to the discipline and patience needed to run a long experiment, the record keeping which that involves and the limited accuracy of any piece of measuring equipment. The project is unlike anything else that they will do at school and for that reason if for no other, interesting.

I live in Leatherhead and I'm trying to start some pilot projects around here to run the experiment.

GNSS equipment is very easy to use and it typically takes about two minutes to find your position, so the scheme accommodates a group of students with everybody taking measurements. This is an exercise for a whole class, not just a few enthusiastic technophiles.

All sorts of interesting side projects can spring from this experiment from hiking and map making through to students making their own survey equipment. My own field is software engineering and there's interesting work to do there too. I've published open-source software to help.

Smartphones have their own GPS receivers on board. One potential side project is to make the same observations with a phone and compare the results.

It may be possible to get sponsorship for this project. Potential sponsors include GNSS equipment manufacturers, IT companies, large construction companies, local architects and estate agents.

The Scout Movement

According to the Scout Association, in January 2023 there were 436,015 young people (4–18 years) and 143,165 adults involved in the Scout movement in local groups across the UK. Accurate GNSS is very relevant to their interest in outdoor activities and orienteering.   Scout groups are just as well placed as schools to run the experiment and it involves all sorts of practices and technologies that fit into their badge scheme.

Training Project Leaders

The groups doing the project will be led by a teacher or a scout leader. To do that, the leaders need to understand all sorts of disparate material. During my early career I taught Computer Science at Coventry University and I've been using accurate GNSS equipment now for a few years. I'm happy to teach potential project leaders what they need to know to run the pilot project.

Local Colleges

Further education colleges and Universities can help support this project within their communities. Some accurate GNSS systems depend on a local fixed base station providing corrections. University College London runs one of these and it covers most of London. Other colleges could do the same for their neighbourhood.

Reference Material

Greg Milner's book *Pinpoint* (pub Granta 2016) is a very readable introduction to the GPS system.

The BBC are currently repeating Chris Packham's 2023 series *Earth* which describes the affect that geological processes continental drift has had on life on Earth*:*
https://www.bbc.co.uk/iplayer/episodes/p0fpwhhm/earth/

Professor Iain Stewart made a TV series for The BBC and the Open University about the history and geology of the Earth called *The Rise of the Continents.* It explains continental drift and its consequences. It's not currently available on the BBC iPlayer but you can buy a DVD copy:
https://www.amazon.co.uk/Rise-Continents-Professor-Iain-Stewart/dp/B00DAJJBEE

Using BBC material for teaching requires permission. See:
https://www.bbc.co.uk/usingthebbc/terms/can-i-use-bbc-content/

There are lots of video animations on the web showing how the continents have drifted over time. This one focuses on the motion of the UK over the last few million years:
https://www.youtube.com/watch?v=5yVfJGNjok0

This video from the American Public Service Broadcasting organisation covers a much longer range of the Earth's existence: https://www.youtube.com/watch?v=DI6SemRT2iY

This YouTube video explains the concepts behind GNSS in very simple terms. The notes also explain how to build your own receiver: https://www.youtube.com/watch?v=Oc1LBFDj2MA

The physics and mathematics behind accurate GNSS systems were described in a paper by Geoffrey Blewitt in 1997 when he was a researcher at the University of Newcastle. (He's now a professor at the University of Nevada.) The equipment does all the calculations so you don't need to know anything about them to use the technology, but the paper gives you useful insights. You can download it from here: https://nbmg.unr.edu/staff/Blewitt Basics of gps.pdf.

(I advise watching the YouTube video before tackling Blewitt's paper.)

Different GNSS receivers use different coordinate systems to describe the same position, which can easily cause confusion. The UK Ordnance Survey produces a useful guide:
https://www.ordnancesurvey.co.uk/documents/resources/guide-coordinate-systems-great-britain.pdf

Ordnance Survey trig points are useful as reference points that you can measure. The website https://trigpointing.uk lists all the trig points in the UK. It's searchable by postcode so if you want to do field trips you can find a suitable trig to visit.