Report of the *Forth Naturalist & Historian* 'Man and the Landscape'
Symposium Saturday November 5th 2011

Celebrating Central Scotland's Geodiversity

Geodiversity is to rocks and landscape what biodiversity is to the plant and animal kingdoms, our Chair, **Mike Thomas** (Stirling), informed an audience of more than 100 in his introduction to the day, *Putting the "Geo" back into diversity*. The idea of biodiversity was introduced in the late 1980s. It focused attention on sustainable development and the importance of conservation, and is linked to arguments about choice for human communities in the face of environmental and social change. So too is Geodiversity, first conceptualised in 1996. Both are critical in how ecosystems function. Both are keys to the management of earth processes and landforms. Both encourage the wise use and appreciation of nature.

In Scotland, *Geoconservation Scotland* raises awareness of geodiversity through the selection and promotion of RIGS (Regionally Important Geological and Geomorphological Sites). There are local groups: the Stirling and Clackmannan RIGS group, for example, has produced a guide to Wolf's Hole Quarry and Mine Wood above Bridge of Allan. The *Scottish Geodiversity Forum* in turn seeks to widen the profile of geodiversity and influence national and local policies and to promote the role and value of geodiversity in education, community involvement, health, the development of tourism and the wider economy. At a global scale, the *Global Geoparks Network* seeks to safeguard and sustainably manage landscapes and geological formations through Geoparks, geological heritage sites of particular importance, guided by rarity or aesthetic appeal. Scotland has Geoparks in Lochaber, the North West Highlands and in Shetland.

Mike Browne worked for 40 years for the British Geological Survey in Edinburgh and is now Chair of *GeoConservationUK* and Vice Chair of *Scottish Geodiversity Forum*. His deep knowledge was presented in his talk as a tour of our region, a 'walking guide' to the geological past and where to see it. We can reach farther back than 460 million years ago (mya) to the Dalradian rocks in Glenshee and the Highland Boundary Fault Trail at David Marshall Lodge above Aberfoyle. Volcanic rocks in the Keltie Burn at Callander and the southern face of the Ochil Hills, conglomerates from alluvial fans and ancient rivers at Wolf's Hole and at Stirling University, sun cracks and even traces of soil formation at the Bracklinn Falls represent the desert climate of the Devonian Period *c.*410 mya. After *c.*355 mya, in the Carboniferous Period elevated relative sea level created extensive coastal plains forming cementstones and mudstones as seen in the banks of Banton Burn near Kilsyth and Ballagan Glen. Later in the Carboniferous Period at 330-335 mya renewed volcanism created lava flows and ash, seen at Todholes on the Bannock Burn

and at the Fintry Loup, and subterranean volcanic sills exposed now in the Gillies Hill quarries at Cambusbarron. In the Carron Valley lavas reached the sea, creating distinctive pillow shapes. As Scotland drifted north from near the equator, climate became tropical. Rainfall increased and tree ferns colonised wetland soils, ferns seen underground in the Birkhill Fire Clay Mine at Bo'ness. Sediment supply from the land was reduced as mountains were lowered and the sea became clear, encouraging coral reefs at Todholes. Coal-forming swamps developed from *c.* 325 mya. Uplift of the Scottish land-mass after the Carboniferous Period led to erosion and no deposition of later rocks. But there is abundant evidence of major glaciations in the last *c.* 2 million years.

The emphasis in his talk was in galvanising local interest in geoconservation. The activities of voluntary groups are diverse, from site survey, improving access to and explanation of key lopcalities, preparing publications and field guides (e.g. McAdam and Clarkson, 1996), running events like road shows and guided walks, and justifying conservation designations to Local Authority plans.

Jim Hansom (Glasgow) began his contribution by listing the global importance of geodiversity in Scotland: the length and richness of the rock record, its fundamental role in the history of the subject, and its peat and soil carbon stocks and how these might influence climate change. In turn these feed into the Scottish Government's *National Performance Framework* in making the nation healthier, wealthier and wiser, stronger, safer and greener. He then focused on the Forth Valley to explain how special our landscapes are, from the Highland Boundary Fault that slices across the Ochils and the Trossachs, the record of former glaciations 12,000 years ago, and sea-level rise 7,000 years ago with its subsequent fall and the dynamism of the rivers. Understanding geodiversity informs near-future climate change adaptation, making us aware of coastal changes (erosion and 'squeezing' of estuaries between a rising sea and a defended coastline), river changes (flooding, drought, channel mobility, erosion/sediment transport), slope and upland changes and soil changes (erosion, nutrient turnover and loss, soil and peat carbon losses).

The Forth valley coastline has particularly diverse landforms and habitats, reflecting long-term climate fluctuations and also past management decisions. Recent relative sea level rise from 'global warming' is the principal driver underlying increasing coastal flood events. Can we accept the current *status quo* or, *''f you want things to stay as they are, things will have to change''* (Giuseppe Lampedusa (1896-1957). The challenge is to appraise our assets and the opportunities available, and consider approaches to manage threats. Some land uses, for example, will pay for themselves. Others will become less sustainable. Flooding and substantial erosion of the seaward edge adds salt water to farmland and agriculture is devalued. Do we 'save' this land? It will be unsustainable to elevate sea walls *ad infinitum*. Here geodiversity becomes something more than adding aesthetic or academic value to our lives, It was argued that this is geodiversity as coastal defence. Only 12% of Scotland is

protected by engineering structures. Natural features like beaches and saltmarshes provide the major contribution. Understanding geodiversity in this context gives us time to adapt and get the response right, making greater financial, societal and ecological savings.

From this *cri de coeur*, **Angus Miller**, the director of *Geowalks* (www.geowalks.co.uk) and current Chair of the *Scottish Geodiversity Forum* explored how to raise awareness among the general public of our rocks and landscapes. A series of beautiful photographs captured the imagination and whetted the appetite. Geologists are learning from nature writing how to capture a new audience (e.g. Fortey 2005, 2010; Vince 2011). New technologies using animated film (www.rockopera.org.uk) are reaching school children. iPhone applications (apps) are increasingly available. But working in the field is by far the best form of communication. *Geowalks* is a company which guides people around Scotland, introducing people to the geology. Geological Societies, Geoparks, GeoConservation groups, adult education courses and countryside rangers can all contribute. Very complicated geology can be successfully explained. The North West Highlands Geopark, for instance, presents the story of the Moine Thrust at Knockan Crag, of how two 19th century geologists, Peach and Horne, came to think the unthinkable, that enormous chunks of rock can be thrust up and over other rocks in mountain building (Oldroyd 1990).

After lunch, **Eileen Tisdall** (Stirling University) gave a 'lesson for geoconservation' in her analysis of the recent events behind trying to protect the Callander Moraine from sand and gravel quarrying. The moraine is a curving wall of glacial boulder clay crossing the A84 immediately east of Callander. The most stunning views of it are in the wood north of the A84 at Auchenlaich, on the way to the Bracklinn Falls where it suddenly rears up in front of the visitor. The moraine is where a valley glacier originating in a large icefield on Rannoch Moor ground to a halt some 12,000 years ago, in a period called the Loch Lomond Stadial, the last glacial period in Scotland. The Callander region is a classic study area for glacial geologists. Many localities on both sides of the River Teith were where many of our ideas about this 'cold snap' were thought out. This is recognised for this in the Geological Conservation Review of Scotland in 1993 (Lowe, 1993).

As the glacier halted, meltwater from its snout constructed thick deposits of sand and gravel eastward. These deposits are of considerable economic importance in an area also of high recreational value, and is recognised as such in the Loch Lomond and Trossachs National Park Local Plans for 2001 and 2005: the boundary of the Park lies just to the east. The wood itself and the ground around it are highlighted for their touristic value, the area east for rural activities. However, in 2011 it was proposed that ''*those parts of the Callander moraine which have not been subject to mineral extraction and fall within the western boundary of the site*'' should be excluded from management controls, although development should avoid ''*intact sections of the moraine*". It emerged also that

the National Park saw the area as significant for its wildlife habitats and archaeology only, not its geology. The moraine still faces an uncertain future. Eileen reflected on what needs to be learned from this study. One issue faces all RIGS and conservation bodies, in how best to communicate between enthusiasts, academics and bodies like Government, the Park Authority, landowners, industry and the local community. What is valuable and to whom? Clearly the lines of communication broke down in this case, resulting in hasty rearguard actions in arguing the case for geoconservation. But there are deeper issues related to protection. How do authorities draw lines on maps to protect rocks, sediments and landforms when it is the landscape that is of intrinsic value?

In his talk, "Geodiversity and the built heritage", **Ewan Hyslop**, Depute Director of Historic Scotland, considered the implications for care and conservation of buildings held for the nation. Buildings of importance and of architectural value are degrading through attack from the weather, acid rain, subsidence and poor quality construction and repair. They need to be repaired, and the repairs need to blend in, to be authentic and in character. This has created a problem. In the 19th century there were some 8,000 sandstone quarries supplying the building industry in Scotland. Now there are six. The stone available for repair is not that used in construction. Stone for Edinburgh used to be the Craigleith Sandstone in the Midland Valley: now sandstone comes from the English Peak District. One sandstone is not like another sandstone, unfortunately. They vary not only in colour but also in their mineralogy, grain size, density and, critically, porosity. Porous stone cracks by freeze-thaw, and absorbs rather than repels water. Colour fades or changes with weathering. Solutions to this issue have come recently by careful detective work in identifying original quarry sources, and in some cases making them productive again, not for general use in building but to keep our best buildings looking their best.

It is rare for the *FNH* symposium to cover something in the news but our final speaker, **Chris Sangster**, the CEO of Scotgold Resources Ltd., had recently been given outline approval for developing a gold mine at Tyndrum. Only 10 days after our symposium the BBC showed in a fly-on-the-wall documentary showing how tortuous has been the path to this point. Chris' talk was titled '*Gold in Scotland with reference to Scotgold's Grampian Gold Project'*. The current (2011) price of gold is at a record high, around $1,750/oz. Economic deposits around the world range from those with tens of thousands to tens of millions of oz of gold with significant occurrences exceeding 1 million oz: that at Cononish presently stands at 160,000 oz. Globally, the mined supply of gold is around 2,400 t per year, worth some US$124 billion, while central banks hold between 30 to 40,000 t, 15 years supply, currently worth US$1,800 billion.

Scotgold Resources Limited primarily focuses on gold in Scotland, traditionally panned in Scottish rivers in Helmsdale, the Ochil Hills, Leadhills, the Angus Glens and Tyndrum. Scotgold Resources Ltd. now has Crown

exploration licenses covering 3,200 km² in the South West Grampians, the Grampian Gold Project, to mine the ore underground. Gold was discovered in 1984 by Ennex Int. with exploration by 101 surface diamond drill holes (a length of 15,166 m) and 54 underground diamond drill holes with 1,280 m of underground development. Planning approval was gained in 1996 but low gold prices led to a regime of care and maintenance only until Scotgold acquired the mine in 2007. Production should commence in 2013: the current life of the mine is predicted at approximately 8 years.

The Cononish Gold and Silver Deposit is thought to have 160,000 oz of gold and 596,000 oz of silver. Gold is in fine particles (90 % below 100 microns) around and intergrown with iron and base metal sulphides (Pb, Zn Cu). It is a high grade resource at 11.7 g of gold per ton of rock with a current value of around £150M. Operating costs are estimated at £300 per oz gold extracted. The current extent of planned workings will make the mine about 700 m long and 250 m deep. There will be no surface mining activity. It will have an adit entrance with a spiral ramp, extracting rock in a 2 m vertical slice through the hillside. Blasted, broken rock will be moved along and out of the adit for processing by diesel trucks. Rock is crushed and ground to a fine sub 150 micron size, 'free' gold released by gravity while froth flotation takes out all lead, copper and zinc and remaining gold and silver. The sulphide concentrate (containing Cu, Pb, Zn and Au) will have to be sent by road/rail to smelters in Europe.

Compared to other underground mines, Cononish at 20,000 oz per annum is small in scale. Medium scale ventures mine 160,000 oz per annum and large scale ones in South Africa up to 1,000,000 oz per annum. Mine depths range from 200 m to nearly 4 km below the ground surface. There are, of course, environmental impacts, principally because of significant waste to ore ratios. At Cononish the residue, the fine ground rock, will be stored in a 'tailings management facility' housed in a single acoustically protected building. An engineered containment dam of rock and compacted earth will be built in incremental slices to allow solids to settle out. Some underground disposal of waste will minimise the environmental footprint. Water will be re-circulated and surplus clear water discharged to the Cononish River under SEPA consent, electronically controlled to meet discharge limits for salmonoid waters. Restoration of slopes around the dam will leave a minimal impact on the landscape, which led to one comment after the talk that our future industrial heritage should be seen as equal to our natural heritage.

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Richard Tipping

Plate 1a. Old style livestock fairs held in Drymen came to an end about 1900.

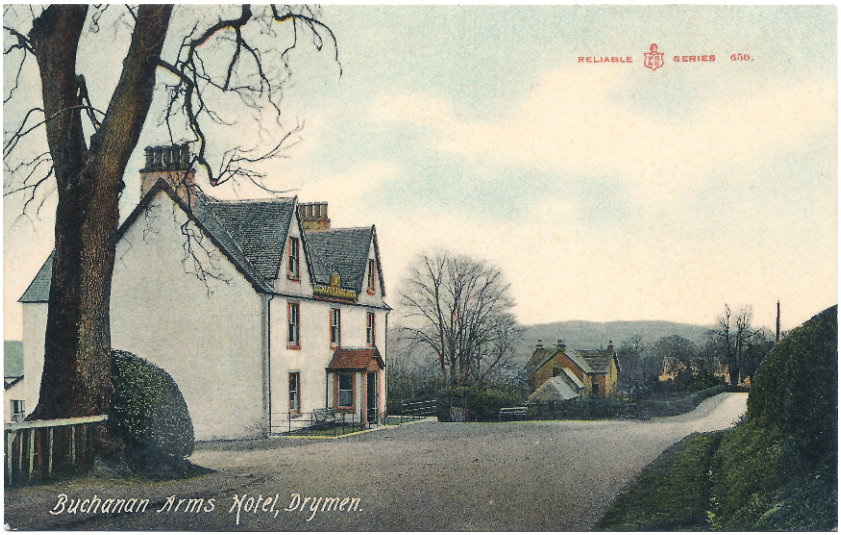

Plate 1b. Picture postcards of where tourists stayed always sold well.

Plate 2a. Drymen Station was an intermediate stop on the former direct rail link between Stirling and Loch Lomond.

Plate 2b. Drymen's main thoroughfare to Stirling before the village expanded eastwards over open fields both sides of the road.

Plate 3. Common butterwort *Pinguicula vulgaris* with rosettes of sticky, gland covered leaves. These trap insects like fly paper and then digest and absorb them.

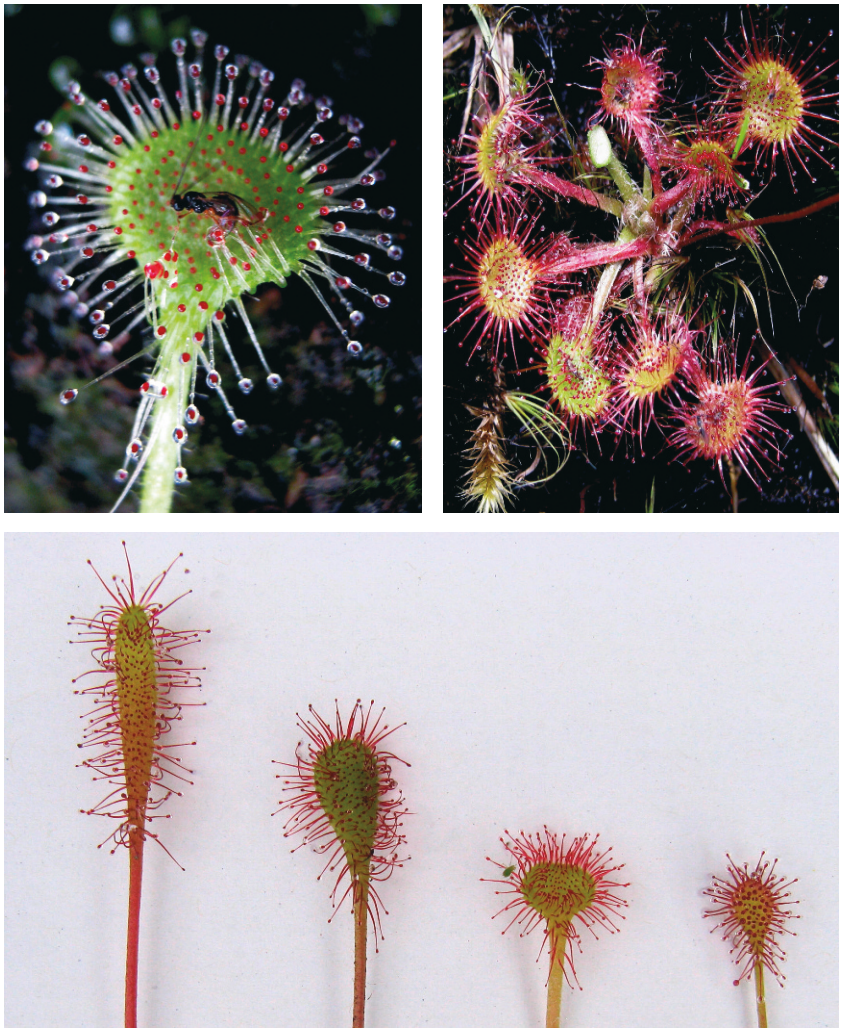

Plate 4. Sundews catch insect prey in the sticky mucilage produced by the tips of the leaf 'tendrils'. Top left: A round leaved sundew *Drosera rotundifolia* leaf twenty minutes after an insect was applied to the ends of its extended tendrils. Those tendrils in contact with the struggling insect have curled inwards bringing it to press against the shorter glands on the centre of the leaf. Later, further tendrils on the opposite side of the leaf folded over the insect finally subduing it. Top right: Plant of round leaved sundew *D. rotundifolia*. Bottom: From left to right leaves of *Drosera anglica; D. x obovata; D. rotundifololia; D. intermedia.*

Plate 5. Top: Lesser bladderwort *Utricularia minor* with its tiny pale yellow flowers protruding above the water. The highly divided leaves with their attached bladders are visible beneath the surface. Bottom: An isolated stem showing the 2 mm diameter bladder traps with the remains of prey which had been sucked into them.

Plate 6. Top left: The showy inflorescence of the greater bladderwort *U. vulgaris* is much bigger and brighter than those of the diminutive lesser bladderwort *U. minor* shown top right. Bottom: These quadrifid hairs which line the bladders are involved in digesting and absorbing the prey. They have been stained to show up under the microscope. The angles between the arms and the relative lengths of the long and short arms are used as taxonomic characters in non-flowering species.

Plate 7.

Buff Footman – *Eilema depressa*

Blair's Shoulder-knot – *Lithophane hesperica*

Crescent Striped – *Apamea oblonga*

Silky Wainscot – *Chilodes maritimus*

Thyme Pug – *Eupithecia distinctaria*

Spindle Ermine – *Yponomeuta cagnagella*

Moth Highlights of 2011
(not to scale)

Plate 8. Greenland white-fronted geese grazing on Loch Lomondside. The characteristic distinctive white patch above a bright orange bill and black stripes or 'tiger barring' across the belly are evident.

Plate 9. Cambuskenneth Abbey – little of the monastic complex remains above foundation level, but the detached thirteenth-century campanile survives to give an impression of the scale and quality of the buildings that were funded on the income from the monastic estate.

Plate 10. Cambuskenneth Abbey from Holy Rude, Stirling – the surviving ruins lie at the centre of the original block of property on the north side of the Forth opposite Stirling that was granted to the canons by King David I.

Plate 11. Cambuskenneth Abbey and the Carse – the monastic estate developed outwards from its original core around the abbey, spreading north-east (centre left) across what became East and West Grange towards Tullibody and south (centre right) over the river into Mobbiscroft and Kersie.

Plate 12. Tullibody Kirk – the parish was appropriated to the abbey in the thirteenth century and its income diverted to the uses of the canons, but this did not mean that they neglected the spiritual needs of the parishioners, Abbot Myln paying to have the church rebuilt in the 1530s to provide a suitable setting for parochial services.

Plate 13. The Dewar Shield. King's Park were the first winners of this trophy in 1898-9. It was last competed for in 1982-83, when it was won by St Johnstone, and it is now on display in the trophy cabinet at McDiarmid Park in Perth.

Plate 14. The Central League winners medal 1904-5 awarded to King's Park half back James Edmond. Photographed with kind permission of Mr John McKail.