Introduction

The North West Highlands Geopark

Located at the most north-westerly tip of mainland Scotland, the Geopark encompasses a substantial part of the County of Sutherland and the Coigach area of Wester Ross, and it covers an area of approximately 2,000 sq.km. The boundary of the NWHG stretches from Cape Wrath and Loch Eriboll in the north to Ben More Coigach in the south. It extends eastwards from the west coast for a distance of about 30 km, to include a major geological structure called the Moine Thrust which runs along the eastern side of both Loch Eriboll and the Assynt area. The Geopark is roughly in the shape of a long, narrow rectangle, with its longer axis running approximately NNE–SSW.

The geology and landscape of the NWHG are, by international standards, outstanding. Four particular aspects of the Geopark identify it as one of the top locations for the appreciation of the Earth Sciences worldwide. These are:-

1. The NWHG contains some of the oldest rocks exposed today on Planet Earth.These rocks are called Lewisian Gneiss and have been dated to around 3,000 million years old.
2. The fundamental crustal dislocation of the Moine Thrust dominates the geology of the Geopark from north to south and is the most significant structure and best example of its type to be seen anywhere in NW Europe.
3. The discovery of the Moine Thrust and the early pioneering work by two 19th Century geologists, Benjamin Peach and John Horne, working from a base at Inchnadamph within the NWHG, completely transformed and advanced geologists' understanding of such structures worldwide.
4. The NWHG contains an outstanding suite of landforms formed during the Ice Ages which preserve an excellent record of past climate change.

The geology and geological structure of the NWHG

In summary, the bedrock geology of the NWHG comprises rocks from four main distinct groups, most of which are considered to have ages in excess of 1,000 million years and occupy more than 70% of the present-day land surface of the Geopark. At the more recent end of the geological time-scale, the bedrock of the Geopark has suffered intense modification and erosion during Glacial times (around 25,000 years ago), resulting in the very dramatic (and iconic) landscape which we see today.

The oldest and most abundant group of rocks is the Lewisian Gneiss (Archaean to Proterozoic) which dates to as far back as 3,000 million years B.P. (Before Present). This is an extremely hard rock with a complex metamorphic and structural history, representing some of the earliest recorded geological rock materials still existing today at the Earth's surface, but which were originally formed by metamorphism (prolonged and intense pressure and heat) at great depths below the contemporary land surface. The Lewisian Gneisses were subsequently intruded by a group of sub- parallel dykes (the famous Scourie Dyke swarm) at around 2,400 million years B.P., followed by later metamorphic events between 1,800 and 1,500 million years B.P. The Lewisian Gneiss is known to form the deep basement bedrock extending beneath the much later (younger) rocks occurring at the surface, further to the south and east outwith the area of the NWHG, across much of the Scottish Highlands.

Resting unconformably on the Lewisian Gneiss is the second main rock-group represented within the NWHG. This comprises relatively undeformed sedimentary strata of the Torridonian Sandstone succession (Neoproterozoic, about 1,200 to 950 million years B.P.) deposited mainly by rivers within a highly undulating contemporary landscape formed within the underlying (and now elevated) Lewisian Gneiss. The main rock-types are arkosic (feldspar-bearing) sandstones, conglomerates and mudstones/shales. Many of the dramatic and iconic mountains within the NWHG are formed of Torridonian Sandstone strata, particularly within the southern half of the Geopark. Some of the Torridonian strata preserve the oldest fossil life-forms to be found in Europe.

The third rock-group comprises much younger sedimentary strata of Cambrian and Cambro-Ordovician age (540 to 480 million years B.P.), consisting mostly of quartzites, muddy siltstones and impure (dolomitic) limestones, lying unconformably on top of the much older Torridonian Sandstone and/or the Lewisian Gneiss. The quartzitic strata typically form capping layers at the top of many of the mountains whereas the limestones have allowed a karst landscape to be developed, especially in the areas around Durness and Inchnadamph. These younger strata have, in part, been severely disrupted by later crustal dislocations along the Moine Thrust Zone, at about 430 million years B.P., when older rocks called Moine Schists (the fourth main rock-group, originating mostly as sandstones with some shales at about 1,000 million years B.P.) were pushed (or “thrust”) towards, up and over the younger strata from a starting point much further to the south-east.

It was the discovery and understanding of the Moine Thrust mechanism and its associated rock-structures, mostly by Charles Lapworth, Benjamin Peach and John Horne who were able to unravel the complex geological structures of the North West Highlands during the late 1800s, which has led to this area of North West Europe becoming a “must-see” for geologists from around the world. We now know that the Moine Thrust was the result of extreme horizontal (compressional) crustal forces which were created when a crustal plate called Laurentia (carrying Scotland) collided with two plates called Avalonia (carrying England) and Baltica at about 430 million years B.P. Also at this time, the associated crustal compression created a vast mountain chain further to the south. This Caledonian Mountain Belt stretched all the way from Newfoundland to Ireland, through Scotland and on to Scandinavia.

The present-day landscape of the NWHG is essentially a dramatic rock-scape formed as a result of successive glaciations. Long, dramatic U-shaped glacial valleys, gouged into the hardest of bedrock (Lewisian Gneiss and Torridonian Sandstone) are typical within the Geopark as are Inselbergs (or “Island Mountains”) formed by remnant ridges of Torridonian Sandstone rising above a lower platform of Lewisian Gneiss. Classic glacial moraines and fluvio-glacial features also occur.

The purpose of the Audit and Action Plan

There is a requirement to undertake an audit of the numerous geological and related features occurring within the NWHG in order to be able to effectively manage, interpret, conserve and protect the geological heritage of the NWHG, upon which its status as a Geopark fundamentally depends. This initial audit includes all the Geological Conservation Review (GCR) sites within the Geopark, and a number of other important geological features. It should be noted that is not exhaustive, but an initial register of the key sites that creates a foundation from which to work.

Whilst there is also a related requirement to undertake an audit of the existing information (ie. interpretation, relevant scientific papers, booklets/guides, etc.), this document only identifies the key physical features that are present within the Geopark.

Geodiversity

There are several (very similar) definitions of Geodiversity in regular use today. The definition being adopted for the present purpose is “the variety of geological environments, phenomena, rocks, fossils, minerals, processes, landforms and soils which underlie and determine the character of our landscape and environment and which provide the framework for life on Earth”. Geodiversity is fundamental to almost every aspect of life. It is the bedrock of our environment and an important factor in our cultural identity. Geodiversity links people, landscape, biodiversity and culture, and is an important natural resource.

A comprehensive Geodiversity Audit is the most up-to-date available knowledge of an area’s geology, soils, landforms and landscapes, together with the processes and phenomena which have formed them and continue to influence them. The purposes of an audit typically include:-

- Encouraging local interest in geology;
- Increasing public awareness of Geodiversity through a range of approaches, including maps and guides, geotourism, guided walks and events, etc.;

- Engaging commerce and industry, local communities, voluntary groups and local societies in conserving the area's Geodiversity;
- Designating and maintaining data on important local/regional geological sites;
- Identifying opportunities and recommending strategies for the conservation and enhancement of geological features;
- Ensuring that important geological sites and features are recorded, conserved and not lost to development;
- Ensuring that policies protecting Geodiversity are included in local and regional policies and strategies;
- Monitoring the condition of sites;
- Identifying and prioritising sites in need of practical conservation management;
- Improving the appearance of active and disused quarries, and managing or restoring them in a way that complements and enhances the character of the local landscape, Geodiversity and biodiversity;
- Encouraging quarry operators to prepare quarry-specific Geodiversity Action Plans and seek opportunities to report, record, conserve and enhance Geodiversity in active quarries;
- Encouraging awareness and use of local materials for repair and new-build;
- Providing education and training opportunities for local schools, higher and further education, engineers, builders and architects, local tourist guides, etc.;
- Promoting research into local Geodiversity.

The undertaking of an audit of the NWHG is clearly an important stage in the management and conservation of the Geopark. It is a pre-requisite to the development of a Local Geodiversity Action Plan (LGAP) which forms a vital tool in the long-term strategic management of a Geopark. This audit therefore forms the basis of the NWHG LGAP which is in Part 2 of the document. In essence, the audit provides a Geodiversity Asset Register upon which the LGAP is based.

This Audit and Action Plan has been developed in consultation with the British Geological Survey (BGS) and Scottish Natural Heritage (SNH). There may be an ongoing requirement, however, to periodically review its relevance to any local developments subsequently occurring within the Geopark and update it as is appropriate.