Economic Impact of the Geoscience Industry on the Northern Ireland Economy

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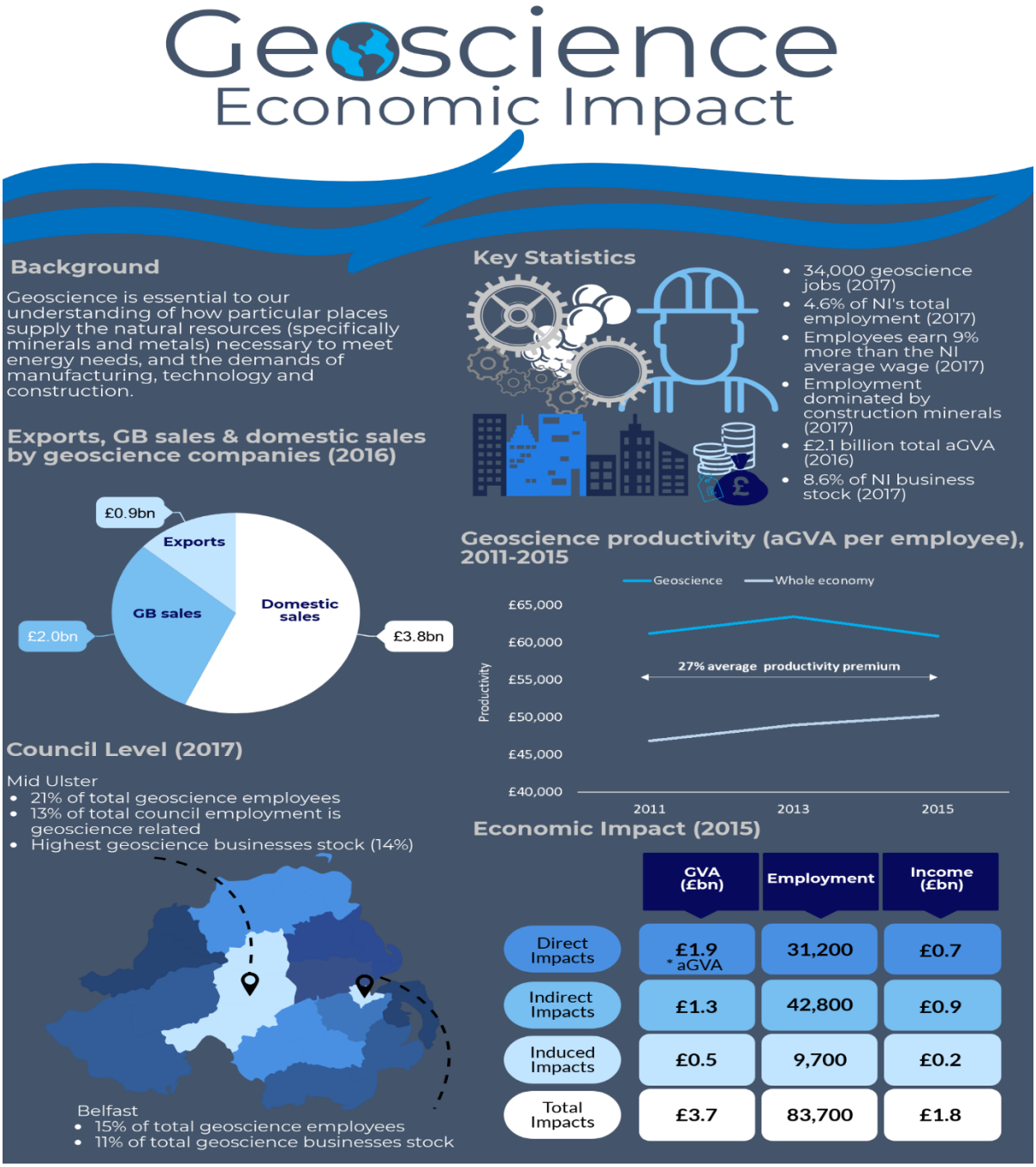
Executive Summary

Geoscience includes a series of activities connected to the extraction and processing of natural resources (specifically minerals and metals) to meet the needs of energy supply, manufacturing, technology and construction.

The full economic impact of the geoscience industry to the wider NI economy (as shown in the infographic below) is calculated to be 83,700 jobs, £3.7 billion in Gross Value Added (GVA) and £1.8 billion in wages. The respective Type II multipliers are 2.7 (jobs), 1.9 (GVA) and 2.5 (wages). These are all significant figures, equivalent to around 10% of the NI economy being directly or indirectly impacted by the geoscience sector.

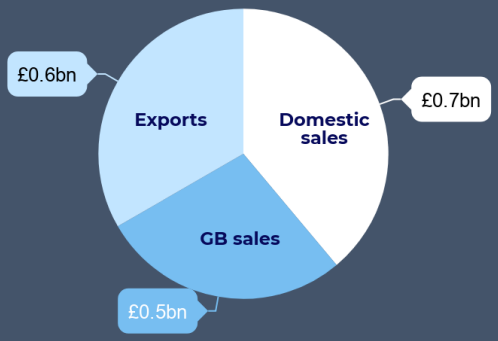


Geoscience
Core Economic Impacts

Core Geoscience

Core Geoscience activities are those which directly support the industry, including the extraction of minerals (mining and quarrying activities), allied industries to that (mining machinery) and the production of materials/goods from the minerals (eg: manufacture of concrete or cement).

Exports, GB sales & domestic sales by core geoscience companies (2016)

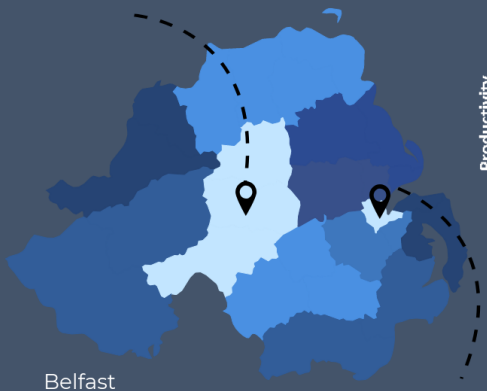


Key Statistics

- 11,500 core geoscience jobs (2017)
- 1.5% of NI's total employment (2017)
- Employees earn 7% more than the NI average wage (2017)
- £0.7 billion total aGVA (2016)
- 1.4% of NI business stock (2017)

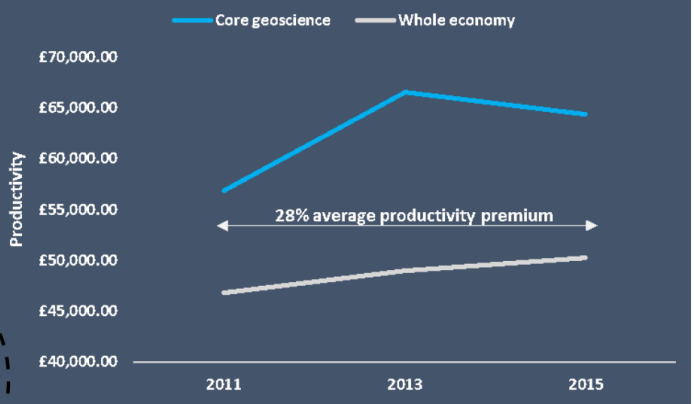
Council Level (2017)

Mid Ulster
- 35% of total core geoscience employees
- 7% of total council employment is core geoscience related
- 14% of total core geoscience business stock



Belfast
- 12% of total core geoscience employees
- Highest core geoscience business stock (15%)

Core Geoscience productivity (aGVA per employee), 2011-2015



The key statistics for the geoscience industry include 34,000 jobs (4.6% share of NI's total employment in 2017), aGVA[1] of £2.1 billion (5.8% share of total GVA in 2016) and 6,150 businesses (8.6% share of the total in 2016). In terms of NI equivalents, geoscience employment is similar to the agriculture sector and the knowledge economy and the GVA total is close to that produced by construction.

There are many positives for the geoscience industry in NI. Employees in the sector earn 9% more than the NI average wage and is the 5th highest paid sector in NI. During the recession, output (as measured by aGVA) remained stable and the industry is the 7th biggest sectoral contributor to the NI economy. Geoscience firms are externally-focussed with 43% of sales (£2.9 billion) going outside NI. The businesses also account for a significant proportion of business expenditure on R&D (BERD) (15% of the NI total). Notably, the industry has higher levels of productivity than the NI average. In the 2011-2015 period the gap between average NI productivity levels and that of the geoscience industry was 27%, a significant premium for the sector.

When compared to other UK regions, the NI geoscience industry has above average shares of the region's employment and business stock, which argues for its significance to the NI economy. In terms of employment, the NI geoscience has the 4th largest share of regional employment in the UK. However, it is below the UK regional average for some key economic metrics – such as productivity levels, the wage premium, and share of GVA.

The geoscience industry has a number of concentrations to note. First, the large (and growing) concentration of both jobs and firms in the Mid Ulster council area. Second, the Construction Minerals sub-sector is the dominant one within the industry (something shared with other UK regions).

A final point connected to these concentrations is that the geosciences and construction industries are deeply connected in the Northern Ireland economy. In part, this is because almost three quarters of the minerals extracted (Basalt, Sandstone and Sand & Gravel) are used in building products and then in projects either in NI or external markets. The industry has also given rise to an NI specialism in the development and production of materials handling equipment, a recent addition to the engineering tradition in the economy and one linked to the extraction and processing of the natural resources. This suggests that the geoscience industry is a strong supporting sector within the economy and has the potential for spin offs such as engineering innovation.

[1] Note that aGVA refers to data sourced from the Annual Business Inquiry/Survey whereas GVA is sourced using national accounts. The total aGVA is around two-thirds of the national accounts whole economy GVA due to differences in methodology. The Annual Business Inquiry provides information on the value of the economic activity that businesses generate and associated expenditure across the main industry sectors in NI. The ABI is designed to provide estimates of turnover and approximate GVA for most sectors in the economy. The main exceptions are the public sector, financial services and the majority of agriculture. Further details can be found at http://www.ons.gov.uk/ons/guide-method/method-quality/specific/business-and-energy/annual-business-survey/quality-and-methods/a-comparison-between-abs-and-national-accounts-measures-of-value-added.pdf

1. Introduction

The Ulster University Economic Policy Centre (UUEPC) was commissioned by the Department for the Economy (DfE) to "***to research the economic value and impact of the geosciences sector to the NI economy and consider the potential of that sector to further benefit the NI economy***".

1.1 Background

Geoscience (sometimes referred to as Earth Sciences) is essential to our understanding of how particular places are able (or not) to supply the natural resources (specifically minerals and metals) necessary to meet energy needs, and the demands of manufacturing, technology and construction. Geoscience also covers a wide range of economic services and activities, from geotourism and education/research to extraction of minerals, care of groundwater and the development of energy resources (such as geothermal). The agreed focus in this report is those geoscience activities, which connect to the extraction and use of minerals and metals.

From a policy perspective, there are several reasons why this report into the geoscience industry in Northern Ireland (NI) is an important one:

1. Geoscience is a long-established industry in NI, but it is little understood outside a small field of experts and firms. Worldwide, NI is recognised within this field as an attractive area for mining investment. Results of The Canadian Fraser Institute's 2018 Annual Survey of Mining Companies[2] show that NI remained ranked in the top 10 with regard to overall policy attractiveness, performing well in the quality of infrastructure, trade friendliness and the quality of geological databases[3]. With regard to the availability of geoscientific data within NI, the survey highlighted the achievements of the Tellus project where a new range of geological and geophysical maps were created using the latest technology. Within NI, any appreciation of the industry needs to begin with the establishment of the current economic value and impact of the sector on the wider NI economy.

2. References to the potential of the NI geoscience industry need to be based upon an assessment of the extent to which the industry is currently contributing to the NI economy. Therefore, the research explores the recent performance of geoscience across key economic metrics and compares these to industry norms in other UK regions.

3. The link between geoscience and at least two sectors prioritised in the draft Northern Ireland (NI) Industrial Strategy[4] - Construction and Materials Handling – raises the issue of the strategic importance of geoscience as a sector in its own right or in a supporting role. The research also assesses this issue.

[2] https://www.fraserinstitute.org/sites/default/files/annual-survey-of-mining-companies-2018.pdf
[3] In these areas NI is ranked 2nd, 9th and 9th respectively out of 91 jurisdictions.
[4] https://www.economy-ni.gov.uk/consultations/industrial-strategy

1.2 Structure and scope of the report

The structure of the report is designed to highlight the impact assessment of the economic value of the geoscience industry to the NI economy while developing a better understanding of the industry's activities.

Section 2 offers a detailed analysis of the key economic metrics for the geoscience sector over the past decade, including employment, GVA, exports and R&D. To provide a wider context on performance, the metrics for NI geoscience are compared to the other UK regions. The UUEPC research team are grateful for the help offered by the Northern Ireland Statistics and Research Agency (NISRA) in providing bespoke data for this section.

Section 3 follows a standard methodology to calculate the full economic impact of the industry on the wider NI economy, including direct, indirect and induced effects.

The final two sections of the report provide further analysis of the NI geoscience industry. Section 4 offers a picture of both the industry's various sub-sectors (through a disaggregated analysis) and its regional spread across NI (through analysis by Council area). Section 5 provides an analysis of mineral production in NI, in order to show both the range of mineral resources extracted locally and contribution made by NI to the wider UK mineral production.

Throughout the report, the analysis disaggregates the geoscience industry in two ways to provide a more detailed picture at both an NI level and in a comparative fashion with other UK regions. The two methods of disaggregation are as follows:

1. Into two component parts:
    - ***Core*** activities which directly support the industry. These include the extraction of minerals (mining and quarrying activities), allied industries to that (mining machinery) and the production of materials/goods from the minerals (eg: manufacture of concrete or cement).
    - ***Non-core*** or those economic activities that are dependent upon, but not exclusively classified as being within, the sector. These include the use of construction or energy minerals (in infrastructural projects or manufacture of plastics), as well as broader energy and groundwater projects (such as heat and air-conditioning installation or construction of water projects).

2. Into eight sub-sectors (where data allows), including:
    - Construction minerals;
    - Energy minerals;
    - Geothermal energy;
    - Groundwater;
    - Industrial Minerals;
    - Metals;
    - Professional Services; and

- Underground energy storage.

The geoscience industry is not a SIC sector in itself and is identified throughout the report through the aggregation of 5-digit Standard Industrial Classification (SIC) 2007 codes (see Annex A for details). As such, the industry and readers should be mindful of this when comparing against established SIC groupings.

2. Metrics for the NI geoscience industry

This section provides detail of the recent performance of the NI geoscience industry across a range of key economic metrics – employment, GVA, productivity, exports and business expenditure on research and development (BERD). Where possible under each metric, the performance and wider contribution of NI geoscience is compared to the industry in other UK regions and to other sectors in the NI economy.

2.1 Employment recovering from recession

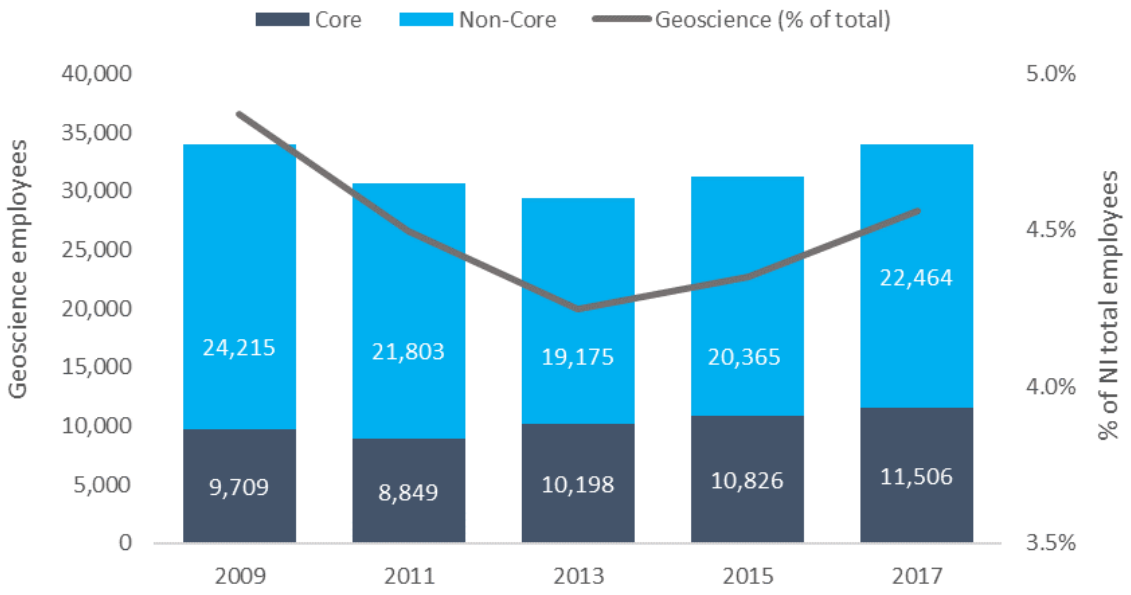
In 2017, there were close to 34,000 employees within the NI geoscience sector making up 4.6% of total NI employment. Two thirds (66%) of the jobs are classified within the non-core component of the geoscience industry. This share is quite typical of the geoscience industry in many UK regions, with only Scotland having a majority of employees in the core part of the industry.

The sector was in decline during the recession and has only just returned to the 2009 levels in the most recent year (see Figure 1). Between 2009 and 2013 the geoscience industry lost 4,550 jobs, an annual decline of 1.4%[5]. The loss can be attributed to a reduction of the non-core elements (-5,040 jobs), which was only partially offset by growth in the core parts (+490 jobs).

In the downturn between 2009 and 2013 the economy lost a total of 46,000 jobs, with construction the worst hit sector (-28,000 jobs or 61% of the total losses[6]). These years indicate the ties of the geoscience industry to the wider NI economy, in particular the construction sector, with the large concentration of geoscience employees within the construction minerals sub-sector. Given this, it is unsurprising how the recession undermined the employment strength in geoscience.

[5] Calculated using a compound annual growth rate
[6] Source: ONS workforce jobs

Figure 1: Geoscience employees, total vs percentage of NI total, 2009-2017

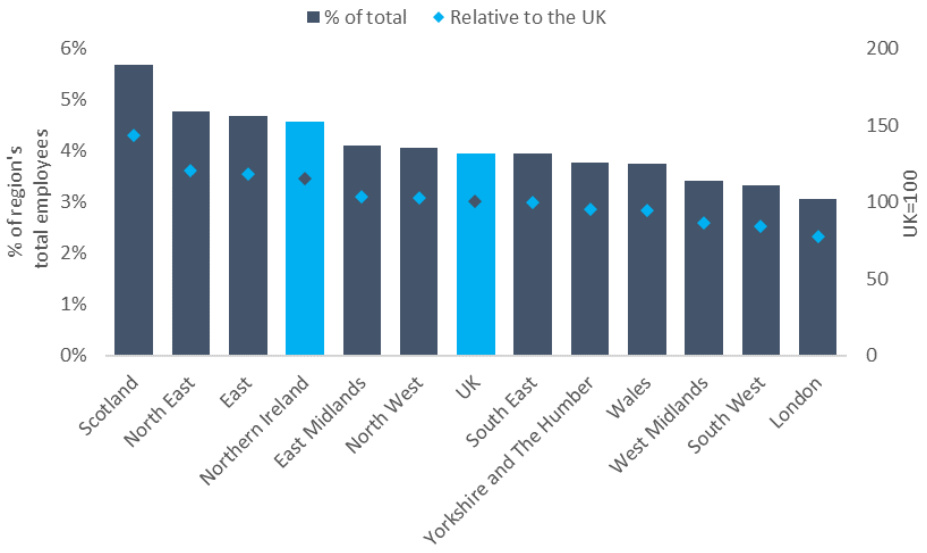


Sources: Business Register and Employment Survey (BRES) & UUEPC analysis

Since 2015 both the core and non-core components have contributed to a recovery in the geoscience industry. The former has grown by 6% and the latter by 10%, delivering a total growth of 9% in employment. Despite the 10% growth, jobs in the non-core sector lag behind the 2009 levels by 7% (or 1,750 jobs). The core sector has exceeded the 2009 levels by 1,800 jobs. This equates to growth of 19% over the whole period and means that the core component has grown its total industry share by 5 p.p. This trend in industry shares has also occurred in most UK regions.

Looking at the importance of geoscience employment to the various UK regions (see Figure 2), Scotland has the largest proportion of its workforce classified within the geoscience industry. At 5.7%, the Scottish share is 1.5 times that of the UK average (3.8%). NI has the 4th largest proportion at 4.6%.

Figure 2: Geoscience employees, percentage of region total & relative to the UK average, 2017

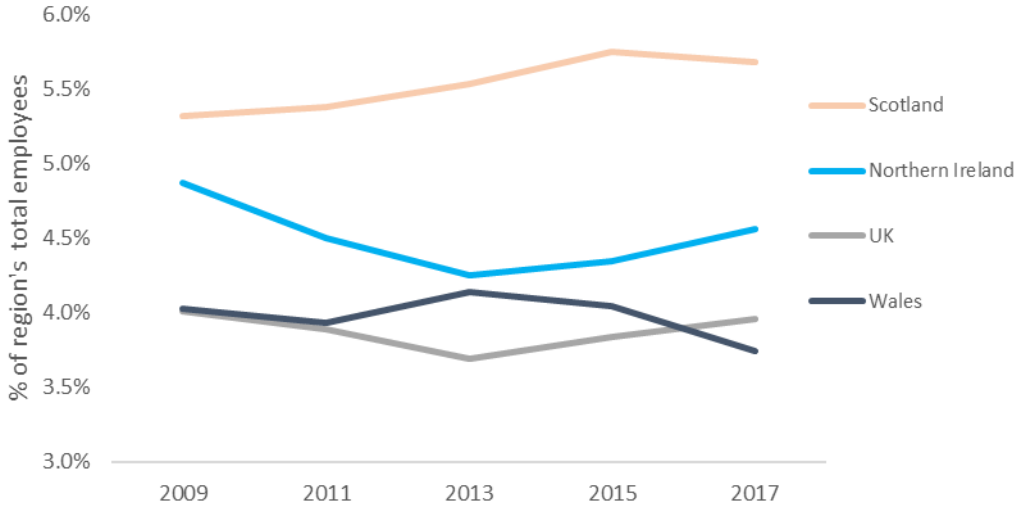


Sources: Business Register and Employment Survey (BRES) & UUEPC analysis

Looking specifically at geoscience's share of total employment over time, Figure 3 shows that, for the devolved regions of the UK, only Scotland has seen an increased share since 2009. NI's recovery bringing employment levels back to the 2009 levels has been accompanied by an overall decline in the share of total employment. Geoscience's proportion of total employment in 2017 is 6% lower than it was in 2009, as employment in other sectors has grown more significantly.

The NI pattern mirrors the UK, albeit that the UK share is almost back to where it was in 2009. Scotland's geoscience industry has continued to increase as a proportion of the total over the period, adding on 13,000 employees, while Wales has actually gone into a sharp relative and small absolute decline since 2013.

Figure 3: Geoscience employees, percentage of region total, relative to 2009 proportion, 2009-2017

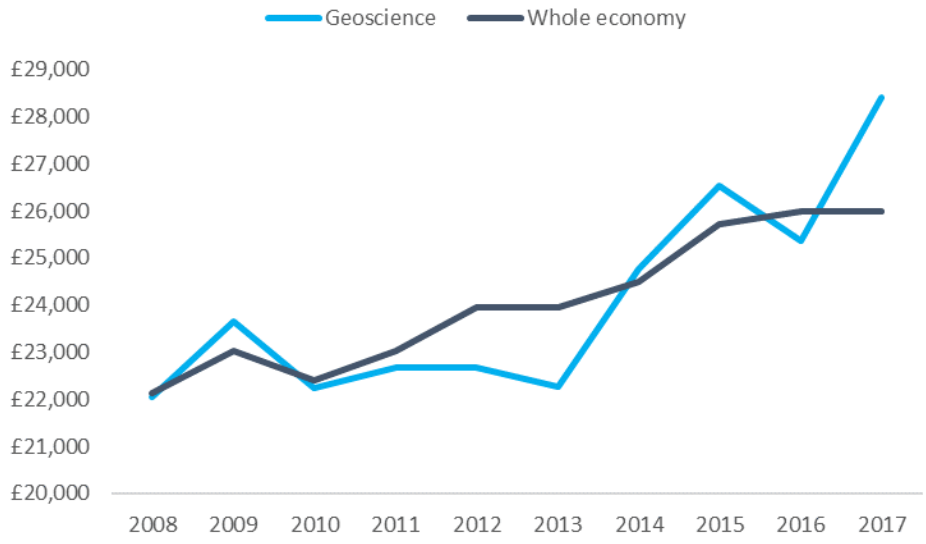


Sources: Business Register and Employment Survey (BRES) & UUEPC analysis

2.2 Rising wages

Employees within the geoscience industry currently enjoy a wage premium, earning 9% more than the NI average. Figure 4 shows that the premium has not been consistent over time. The geoscience wage grew at a faster rate than the NI average over the whole period 2008-2017 (29% vs 18%), but geoscience wages were below average and remained relatively stable between 2010 to 2013.

Figure 4: Median full-time annual earnings, geoscience industry and NI, 2008-2017



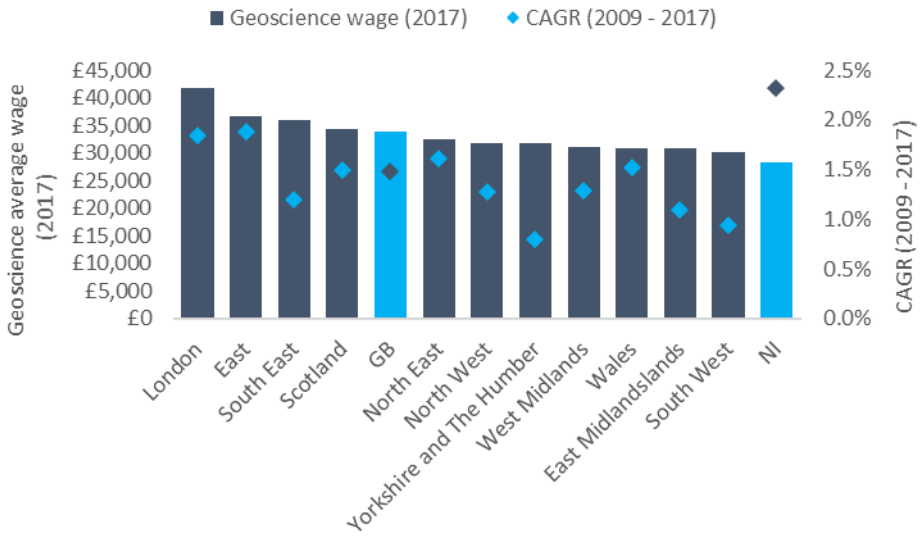
Sources: Annual Survey of Hours and Earnings (ASHE) & UUEPC analysis
Note: Refers to median full-time annual earnings by employees on adult rates, who have been in the same job for more than a year.

As with the employment data the wages data shows how the geoscience industry in NI was significantly impacted by the 2008 recession. Since 2013, however, both wages

and employment have been on the increase - evidence of the recovery in the geoscience industry.

Even though employees within the NI geoscience sector enjoy a local wage premium, Figure 5 shows how, in a UK regional context, the NI geoscience wage is the lowest. The average geoscience wage in 2017 in NI is almost £2,000 lower than the next region, South West, and 84% of the GB average. The gap between the NI sectoral wage and the average UK wage can be found across every sector. The 16% gap is similar to the same as the NI/UK private sector gap in 2017. However, geoscience wage growth in NI has been growing at the fastest annual rate (a CAGR of 2.3% compared to 1.5% for GB).

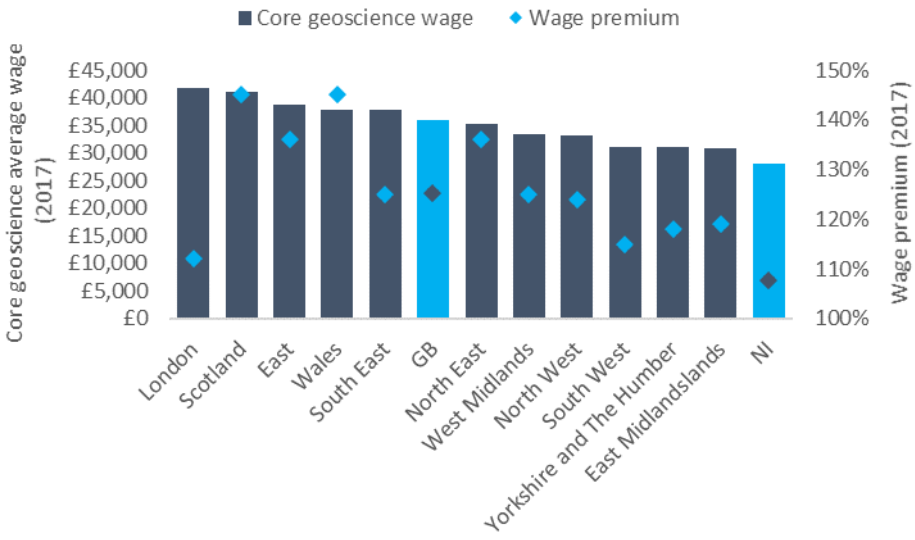
Figure 5: Median full-time annual earnings and annual growth rate, geoscience industry, UK regions, 2009 - 2017



Sources: Annual Survey of Hours and Earnings (ASHE) & UUEPC analysis
Note: Refers to median full-time annual earnings by employees on adult rates, who have been in the same job for more than a year.

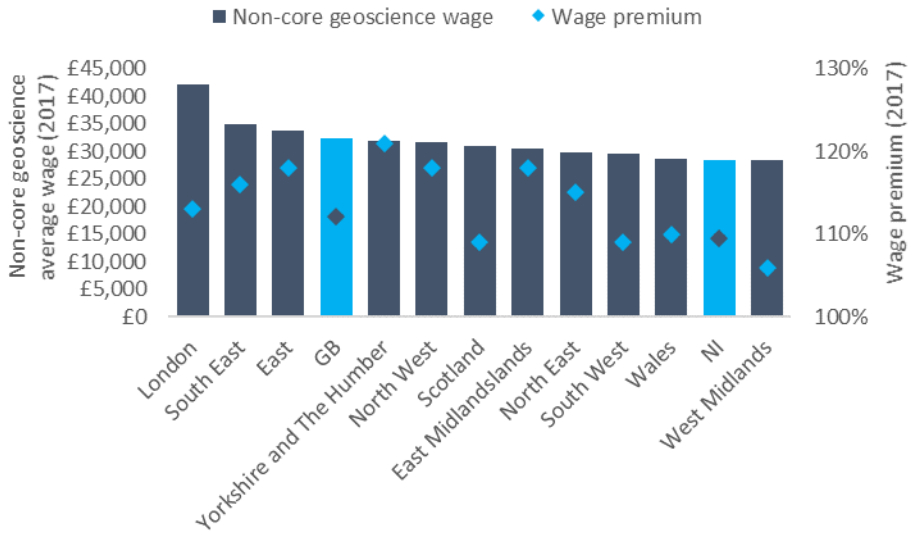
When disaggregated into the core and non-core sectors of the industry (see Figures 6 & 7), core geoscience employees across the UK are paid significantly higher wages than their local peers. Scotland has the highest wage premium for core employees, at nearly 1.5 times the average. Non-core employees also benefit from a wage premium, however for most regions (NI being one of the few exceptions), this is not as significant as that of core employees.

Figure 6: Median full-time annual earnings and wage premium, core geoscience industry, UK regions, 2017



Sources: Annual Survey of Hours and Earnings (ASHE) & UUEPC analysis.
Note: Refers to median full-time annual earnings by employees on adult rates, who have been in the same job for more than a year.

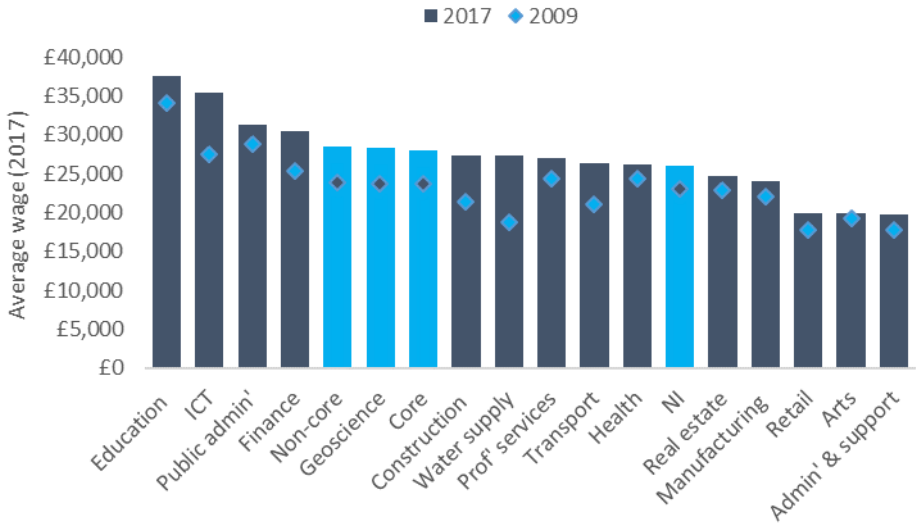
Figure 7: Median full-time annual earnings and wage premium, non-core geoscience industry, UK regions, 2017



Sources: Annual Survey of Hours and Earnings (ASHE) & UUEPC analysis

Given the wage premium above the NI average, it will be no surprise that, when compared to other industries within NI (see Figure 8), geoscience is the 5th highest paid sector with wage rates just below that of those employed within the finance industry, but higher than construction employees.

Figure 8: Sectoral median full-time annual earnings, NI, 2017



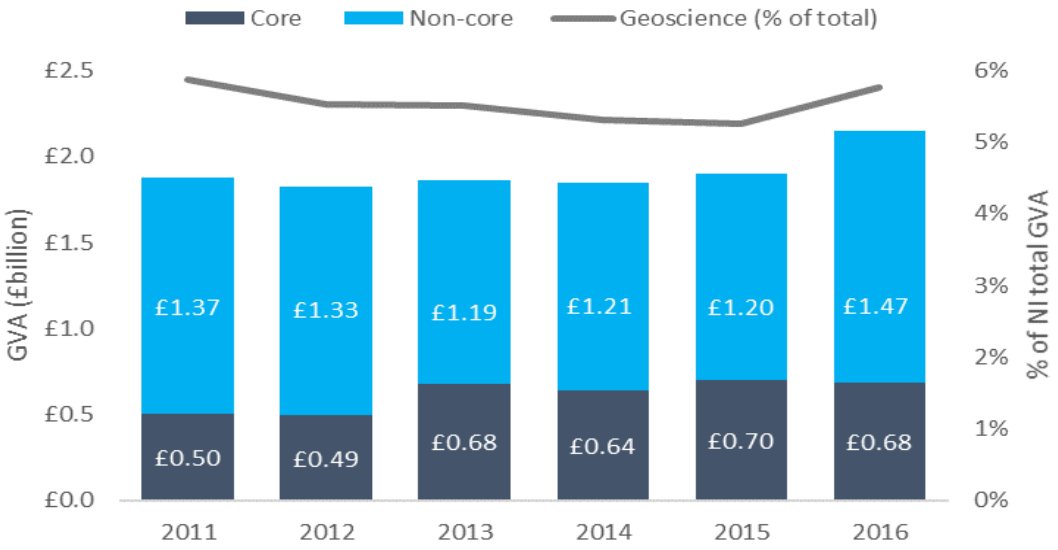
Sources: Annual Survey of Hours and Earnings (ASHE) & UUEPC analysis

Notes: (1) Refers to median full-time annual earnings by employees on adult rates, who have been in the same job for more than a year. (2) 2009 data used for comparison as this is the first year of published data for industry wages based on SIC07. (3) For 2009 non-geoscience sectors, gross weekly wages have been converted to gross annual wages by applying the NI 2009 ratio. (4) Agriculture, mining, hospitality and other service activities have been excluded from the chart as the relevant 2017 wage data was not available due to unreliability issues.

2.3 Output resilient

The geoscience industry contributed just over £2.1bn of aGVA in 2016, representing 5.8% of total NI GVA, a larger percentage share than that of employment. Figure 9 shows that the output of the geoscience industry has seen growth since 2011.

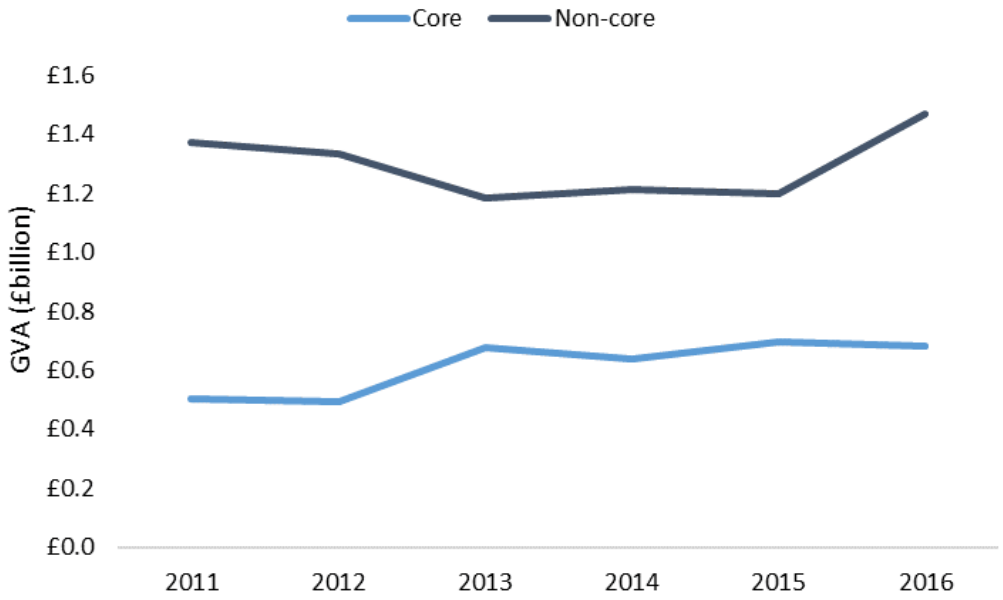
Figure 9: Geoscience aGVA (£billion), total aGVA vs percentage of NI total GVA, 2011-2016



Sources: NI Annual Business Inquiry, ONS regional accounts & UUEPC analysis

On closer inspection, the resilience of output from 2011 through to 2015 is attributed to the performance of the core geoscience sector (see Figure 10). During this time, output of the core sector increased by 39%, partially offsetting the decline in the non-core sector (13%). Only in the most recent year of data has the non-core sector recovered to its 2011 peak. In totality (2011 – 2016), annual average growth for the non-core sector was 1%, and 6% for the core sector.

Figure 10: Geoscience aGVA (£billion), core vs non-core, 2011-2016



Sources: NI Annual Business Inquiry & UUEPC analysis

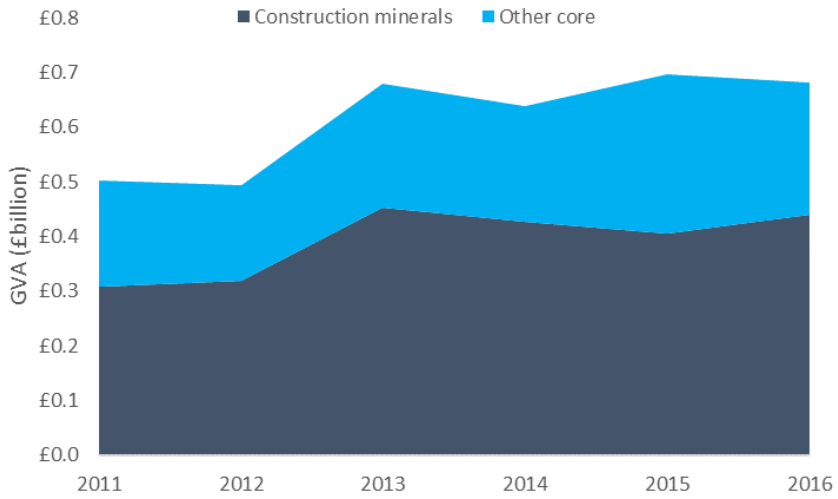
This raises the question of why did the core sector not only maintain, but increase output during a period where jobs were lost and wages were in decline. The largest sub-sector of the core geoscience activities is construction minerals, most recently representing 65% of total core output. From 2012 to 2013 core geoscience output increased significantly (38%, £0.2bn), 72% of which originated from construction minerals (see Figure 11). After the increase, output in the sector remained steady. To that end, the NI Annual Business Inquiry provides useful information on how businesses operating within the sector perform on an aggregate basis.

To provide additional context, the Financial Analysis Made Easy (FAME) database has been used to better understand the aggregate data through the performance of individual businesses. During the year in question (2012-2013), the FAME database supports the evidence of resilient business performance within the core construction minerals sector in NI. Although key financial information is not available for all of the businesses, the following selection provides supplementary insight:

- CDE Global - the world's largest campus dedicated to the wet processing of materials in the sand & aggregates, mining, C&D waste recycling, industrial sands and environmental sectors - experienced turnover growth of 39%;

- Tesab Engineering – aggregate crushing specialists and manufactures of Jaw, Impact and Cone Crushers – saw turnover growth of 20%; and
- Kilwaughter Minerals – Silicone Coloured Renders specialising in the construction, industry and agriculture, landscaping and R&D industries – increased turnover by 16%.

Figure 11: Core geoscience aGVA (£billion), construction minerals vs total core, 2011-2016

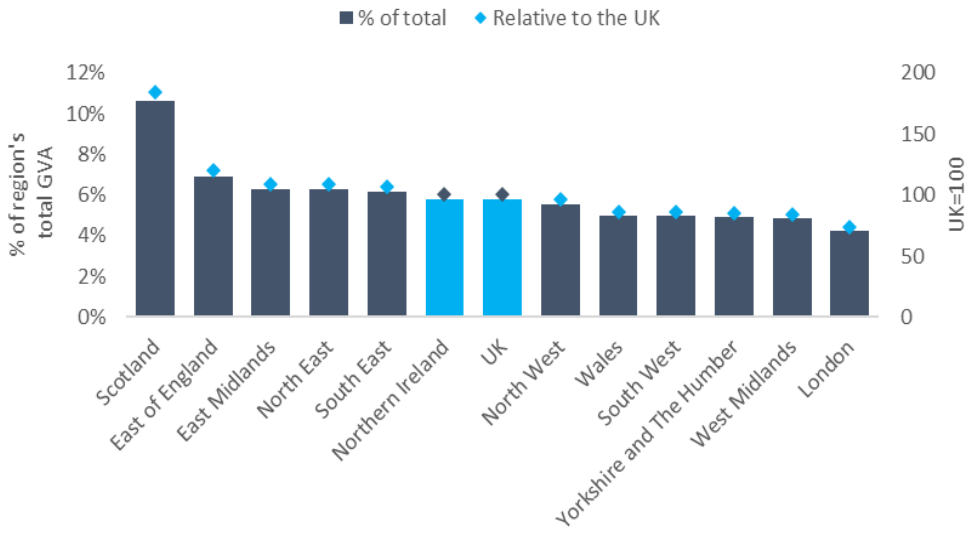


Sources: NI Annual Business Inquiry & UUEPC analysis

When looking at geoscience aGVA across the UK regions, Scotland is an outlier of the UK regions, contributing the largest proportion of GVA (11%). The reason for this is Scotland's high concentration in oil and gas production due to the North Sea oil fields. In 2017, the region accounted for 96% of total UK production of crude oil and natural gas liquids (NGLs), and 62% of natural gas[7]. Whilst the proportion of GVA attributed to the geoscience industry is higher in Scotland relative to other regions, it is significantly lower than earlier years - in 2011, the industry represented 24% of GVA. The decline is a resulting effect from a fall in oil and gas sales income which fell by 48% from 2011 to 2016. Figure 12 shows that NI sits mid-table at the same rate as the UK average (6%).

[7] Source: Oil & Gas Production Statistics 2017 - 18

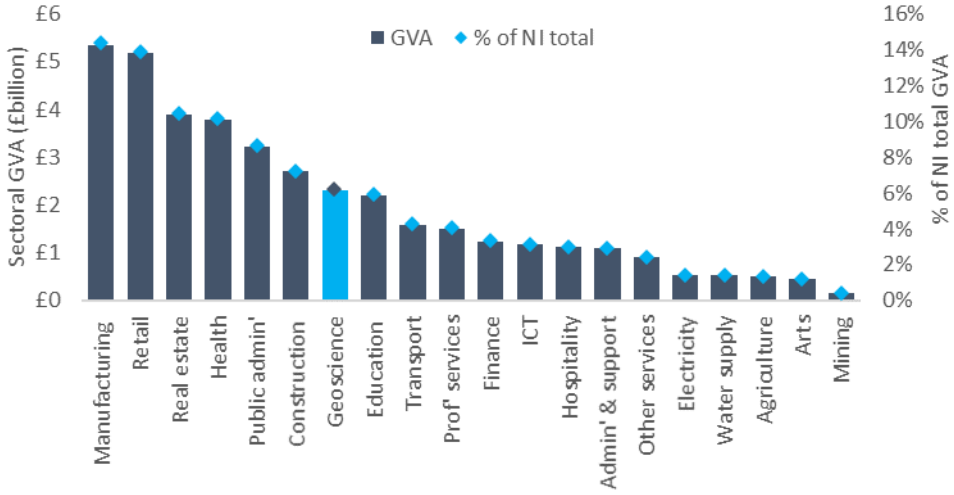
Figure 12: Geoscience aGVA, relative to the UK vs percentage of total GVA, UK regions, 2016



Sources: Annual Business Inquiry, ONS regional accounts & UUEPC analysis

Relative to other industries within NI, Figure 13 shows that estimated geoscience industry is the 7th largest contributor to total GVA, sitting comfortably in the top half, between construction (7.2%) and education (5.9%).

Figure 13: Geoscience aGVA, total vs percentage of total, NI, 2016

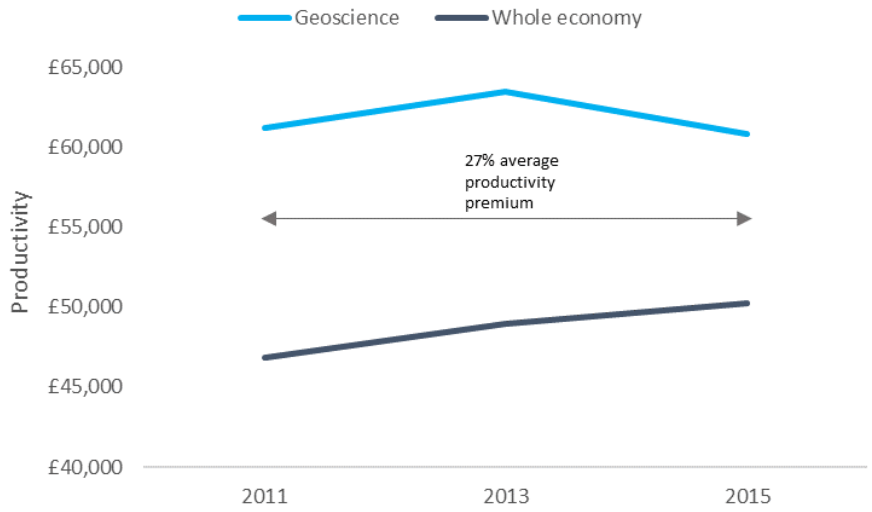


Sources: NI Annual Business Inquiry , ONS regional accounts & UUEPC analysis
Note: Geoscience is a bespoke sector and as such aGVA is used for analysis whereas the other sectors refer to GVA sourced from national accounts.

2.4 High productivity but stalling

Productivity refers to GVA per employee. The NI geoscience industry currently generates a productivity level 21% above the economy average (see Figure 14). During the period, the number of geoscience employees fell by 4%, aGVA fell by 1% and wages increased by 1%. Since 2013 this trend has reversed as a result of employment (+6%) and wage levels (+19%) growing faster than aGVA (+2%).

Figure 14: Geoscience productivity (aGVA per employee), 2011-2015



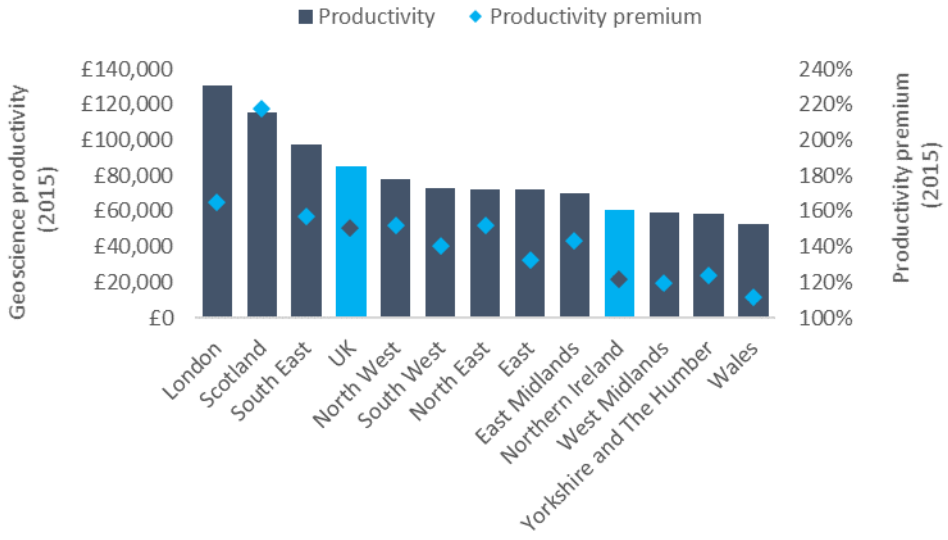
Sources: NI Annual Business Inquiry, ONS regional accounts, Business Register and Employment Survey (BRES) & UUEPC analysis

Notes: GVA uses results from the 'balanced' approach

Figure 15 shows how productivity premiums are present in the geoscience sector across all UK regions, with NI's productivity premium the second lowest after Wales. London's geoscience industry has the highest levels of productivity, perhaps a result of companies that are headquartered within the area – four of the top five leading globally diversified mining companies are listed in London[8]. Additionally, financial institutions principally in London offer expertise with regard to sourcing mining finance. This is an important aspect a development and operation of a successful mine requires access to significant levels of investment capital. Between 2008 and 2011, 51 mining and materials firms made Initial Public Offerings in London, accounting for over 30 per cent of capital raised on the London Stock Exchange. Scotland has the highest productivity premium at 2.4 times the average. This is unsurprising given revenues associated with the oil and gas industry where Scotland dominates.

[8] Delivering Global Mining Solutions – Gov.uk

Figure 15: Productivity (aGVA per employee) and productivity premium, geoscience industry, UK regions, 2015

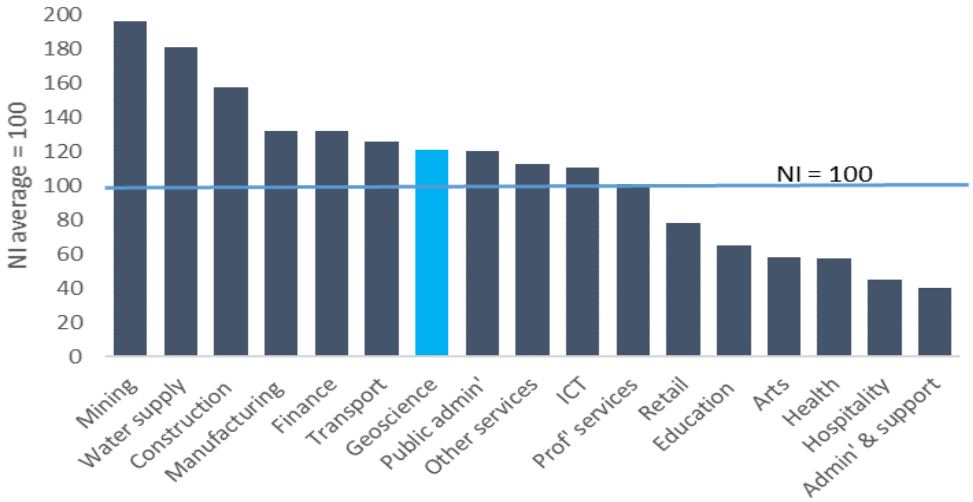


Sources: Annual Business Inquiry, ONS regional accounts, Business Register and Employment Survey (BRES) & UUEPC analysis

Notes: GVA uses results from the 'balanced' approach

Within an NI sectoral context, Figure 16 shows that the productivity of the geoscience sector is just lower than that of the finance and transport sectors, but higher than ICT, professional and other services. Mining and Construction has the highest levels of output relative to input within NI. This sector is encapsulated within the geoscience aggregation thus provides an upward influence on productivity levels.

Figure 16: Sectoral productivity (GVA per employee) relative to the NI average, NI, 2015



Sources: NI Annual Business Inquiry, ONS regional accounts, Business Register and Employment Survey (BRES) & UUEPC analysis

Notes: GVA uses results from the 'balanced' approach
Geoscience is a bespoke sector and as such aGVA is used for analysis whereas the other sectors refer to GVA sourced from national accounts.

2.5 Market focus in NI and beyond

External sales to GB and exports to the rest of the world are particularly important for small open economies such as Northern Ireland. The reason for this is that they generate wealth from outside the region.

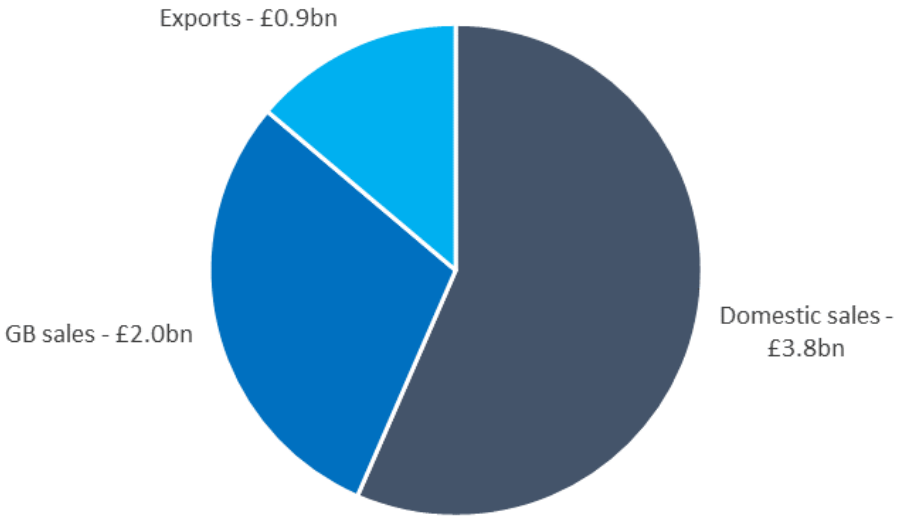
Although a majority (57%) of the value of geoscience sales in 2016 were inside NI, this share is less than the NI economy generally (65% of sales). Figure 17 shows that geoscience firms made £2.9bn of their sales outside the NI economy (£0.9bn of exports and £2.0bn of sales to GB). This represents 9% of total NI exports and 14% of total GB sales – much higher shares than that of employment (4.6%) or GVA (5.8%).

The 30% share of sales to GB is much higher than the NI average (20%), while exports shares are similar (14% vs 15%). The data does not allow a definitive view on the importance of proximity (and therefore the combined GB / Ireland market) to the NI geoscience industry.

As noted above the overall NI geoscience sector is domestically focused. However, on closer inspection (see Figure 18) there is a significant difference between the core and non-core parts of the industry, with the core sector much more externally focussed. The majority (60%) of core sales are to areas outside of NI (25% to GB, 35% to rest of the world), while, for non-core the comparative shares are 31% and 6%. Construction minerals makes up the majority of both exports and external sales within the core sector (72% and 71% respectively). The subsector captures activities such as quarrying and cutting, shaping and finishing of stone. The data suggests relatively high external demand for these goods and services. This could be part explained by the fact that 30% of total UK sandstone production occurs within NI (see section 5 for more detail on minerals). Furthermore, NI is a recognised global centre of excellence in the production of materials handling equipment making 40% of the world's mobile crushing and screening equipment[9].

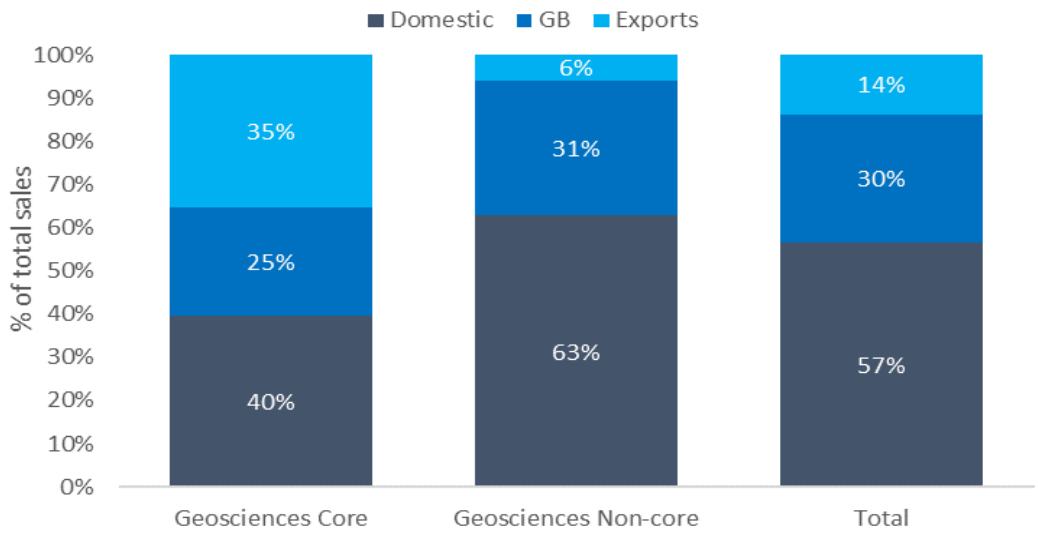
[9] Geological Survey of Northern Ireland (GSNI), Celebrating 70 years: 1947 – 2017; 70th Symposium; Programme and abstracts

Figure 17: Exports, GB sales and domestic sales by geoscience companies, 2016, £bn.



Sources: Broad Economy Sales and Exports Statistics (BESES) & UUEPC analysis

Figure 18: Breakdown of geoscience sales by category, % of total sales, GB sales vs exports, NI, 2016

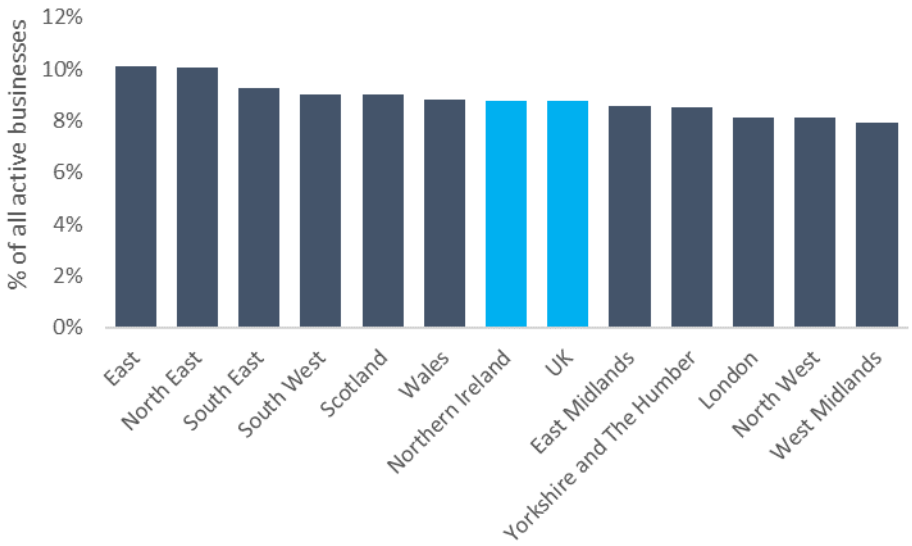


Sources: Broad Economy Sales and Exports Statistics (BESES) & UUEPC analysis

2.6 Geoscience firms

In Northern Ireland geoscience firms represent 9% of total active businesses, a share in line with the UK average. Across all UK regions there are more non-core firms than core.

Figure 19: Geoscience business stock as a % of total, UK regions, 2017

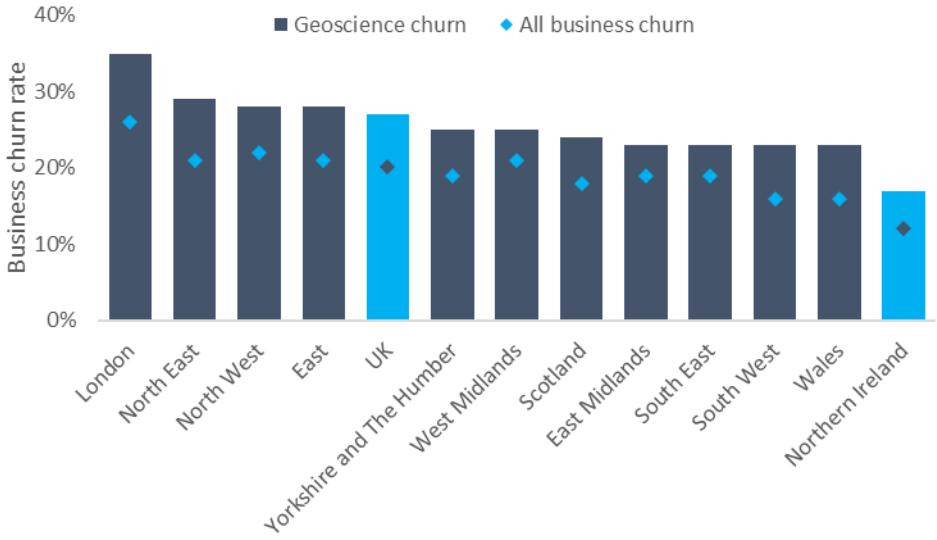


Sources: Inter-Departmental Business Register, ONS (microdata) & UUEPC analysis

Business churn represents the total number of business births and deaths and a proportion of the enterprise population. High churn rates can be interpreted either as representing an entrepreneurial, innovative and adaptive business base that results in enhanced competitiveness, or as a negative where the result is the closure of firms and associated job losses within a region.

The geoscience industry, especially its core component, has a higher churn rate than the overall business base across all of the UK regions. London's geoscience firms have the highest churn rate at 35%, whereas NI has the lowest at 17%. The geoscience churn, shown in Figure 20, follows the regional pattern of the overall business churn. This suggests that the relatively lower churn rate in NI for geoscience firms is a result of the overall NI business environment and not sector specific.

Figure 20: Business churn rate, geoscience vs all business average, UK regions, 2017



Sources: Inter-Departmental Business Register, ONS (microdata) & UUEPC analysis

2.7 Business Expenditure on Research and Development (BERD)

Business expenditure on research and development (BERD) refers to the amount in cash terms a business or a group of businesses spend on research and development (R&D), which can be contracted-out research or R&D done by staff in-house. In 2017, NI businesses spent around £550m[10] on R&D, with the geosciences making up around 15.5% (£84m) of the overall total. Figure 21 shows how the R&D spend in the geoscience sector has more than doubled in the past five years, with R&D spend increasing by around £45m since 2013.

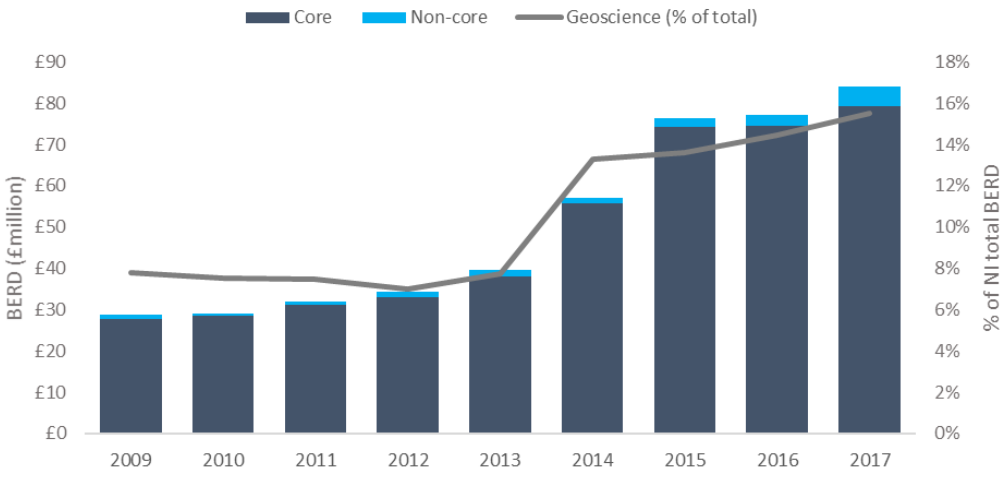
On average since 2008, 97% of all R&D spend within the geoscience sector has been made by core sector firms, with the remaining 3% being made up of non-core firms. The geoscience industry is one that undertakes research and development to build upon and enhance in areas of exploration, excavation and transformation of materials, to name a few. The minerals sector in particular provides materials for construction and as such, supports technological innovation by supplying critical metals essential for new communication and energy technologies.

Since 2005, close to £90m has been invested in searching for and developing NI's high value metallic minerals. According to GSNI, investment used for research exploration has led to the NI now being the most prospected region within the UK and Ireland for gold. Part of this is due to the Curraghinalt deposit ranking top 10 by grade, subsequently bringing NI to the global stage. Furthermore, between 2007 and 2012, NI had the only operating gold mine on the island of Ireland at Cavanacaw.

[10] Figures are presented in real terms based on 2017 prices.

Overall, roughly one quarter of NI is currently under licence for exploration for high-value minerals suggesting full potential has not yet been reached. Companies are continuing to invest time and resources evaluating the prospect of further gold, base metal, platinum group metal and diamond deposits located within the borders of NI.

Figure 21: Geoscience BERD (£million), total vs percentage of NI total, 2009–2017



Sources: NI Research and Development Survey, NISRA & UUEPC analysis

2.8 Summary

The metrics for the NI geoscience industry reveal a number of positives. Employment has recovered since 2013, driven by the core component of the industry. Employees in the sector earn 9% more than the NI average wage, with strong wage growth since 2013. During the recession, output (as measured by GVA) remained stable. Geoscience firms are externally-focussed – 43% of sales (£2.9 billion) are external – and notable R&D performers, accounting for 15% of NI's total BERD. Significantly, the industry has higher levels of productivity than the NI average, with a 27% premium over the 2011-2015 period.

However, the picture is less positive for the NI geoscience industry when compared to other UK regions. Although the NI geoscience industry has above average shares of employment and business stock, it is below average for some key economic metrics, including productivity levels, the wage premium, and share of regional GVA.

3. Direct, indirect and induced impacts of the NI Geoscience industry (2015)

Using data obtained from NISRA, the geosciences industry *direc*tly generates £6.2bn of output to the NI economy, £1.9bn of GVA, and supports 31,200 jobs[11].

The *indirect* (supply chain) impacts of the geoscience industry in 2015 generated an output of £3.2bn. Using the NI Annual Business Inquiry (NIABI[12]) to provide output to GVA ratios, this translates into £1.3bn of GVA. Applying NI sectoral productivity values to GVA provides an estimated figure of 42,800 additional jobs supporting £0.9bn in wages.

The *induced* (spending) effects of the geoscience industry in 2015 generated an estimated additional £0.5bn in GVA, 9,700 jobs and a further £0.2bn of additional wages.

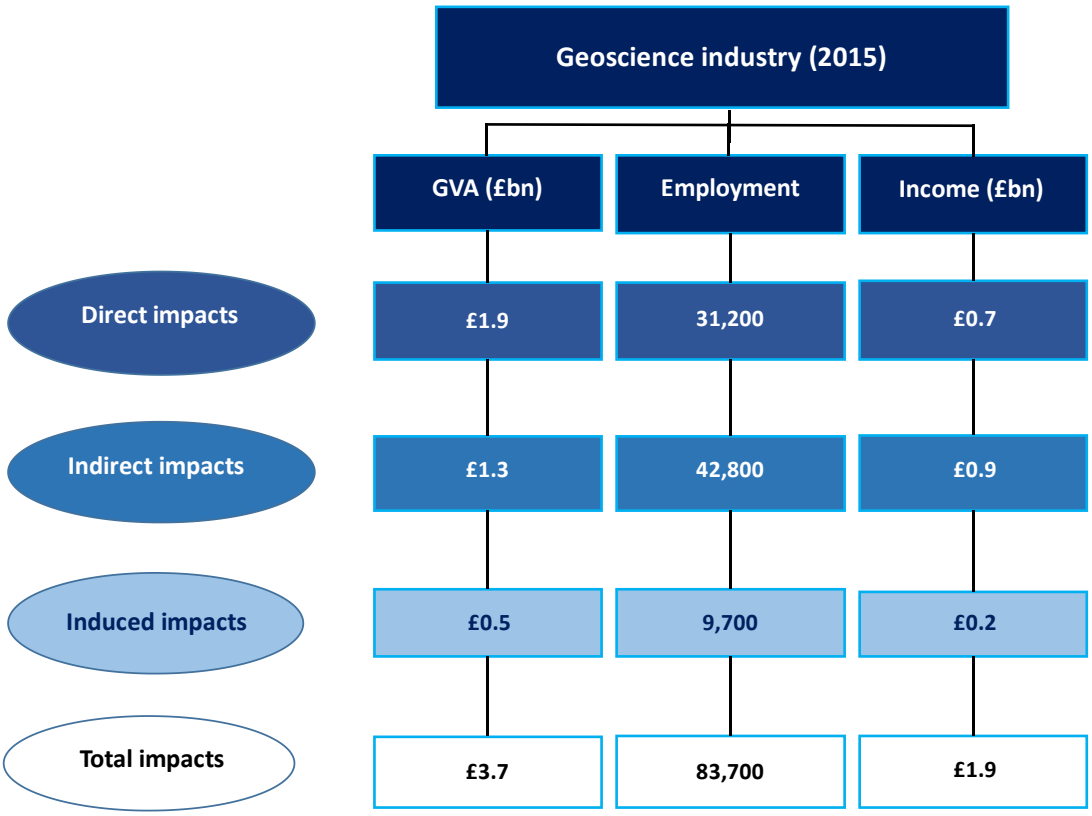
The geoscience industry has large supply chain (type 1) effects as evidenced by a GVA multiplier of 1.7, employment multiplier of 2.4 and income multiplier of 2.3. For GVA, this means that for every £1 of output generated in the geoscience industry directly, £1.70 will be generated as a result of the subsequent buying of goods and services from other firms to meet demand. When the impact is extended to incorporate spending effects (type 2, additional wages spent), the respective multipliers increase to 1.9, 2.7 and 2.5.

In total, Figure 22 details how the geoscience industry supports £3.7bn GVA, 83,700 jobs and £1.8bn wages in the NI economy when we account for direct, indirect and induced effects.

For more detail on how the economic impact has been calculated please refer to Annex B.

[11] 2015 figures have been used for the economic impact analysis as this is the most recent year where all required data is available. GVA and output had been provided up to 2016 and employee data until 2017, however the Business Register and Employment Survey (BRES) data is available only on a bi-annual basis and as such was not available for 2016 resulting in the use of 2015 figures.

Figure 22: Overall economic impact of the geoscience industry, 2015



Multipliers	Type 1	Type 2
GVA	1.7	1.9
Employment	2.4	2.7
Income	2.3	2.5

Source: UUEPC analysis

4. Further analysis of the NI geoscience industry

In this section of the report, the intention is to further analyse the NI geoscience industry, at its sub-sectoral and sub-regional levels. Where possible, data is provided for each of the metrics found in Section 2.

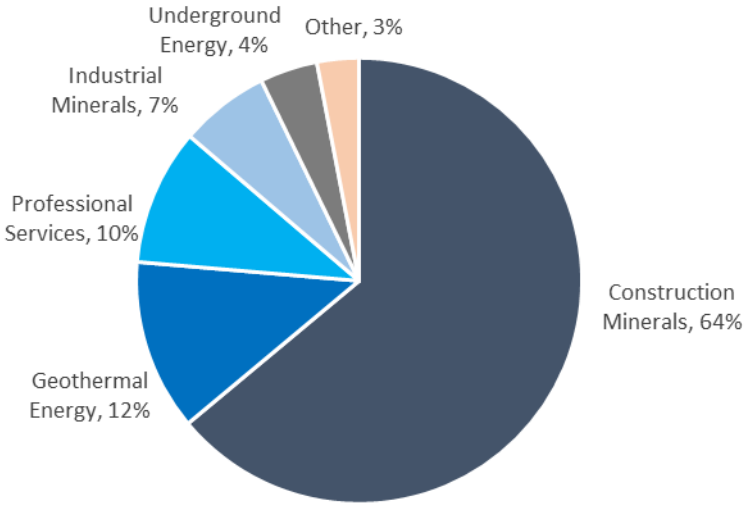
4.1 Sub-sectoral analysis – dominated by construction minerals

The sub-sectoral analysis in this section is based upon a division of geoscience activities into the following groupings of 5-digit SIC07 codes (see Annex A for more detail):

- Construction minerals;
- Energy minerals;
- Geothermal energy;
- Groundwater;
- Industrial Minerals;
- Metals;
- Professional Services; and
- Underground energy storage.

With regard to employment in the subsectors of the industry, Figure 23 shows how Construction Minerals represents the majority of jobs (64%), followed by Geothermal Energy (12%) and Professional Services (10%).

Figure 23: Employment by geoscience sub-sector, % of geoscience total, 2017



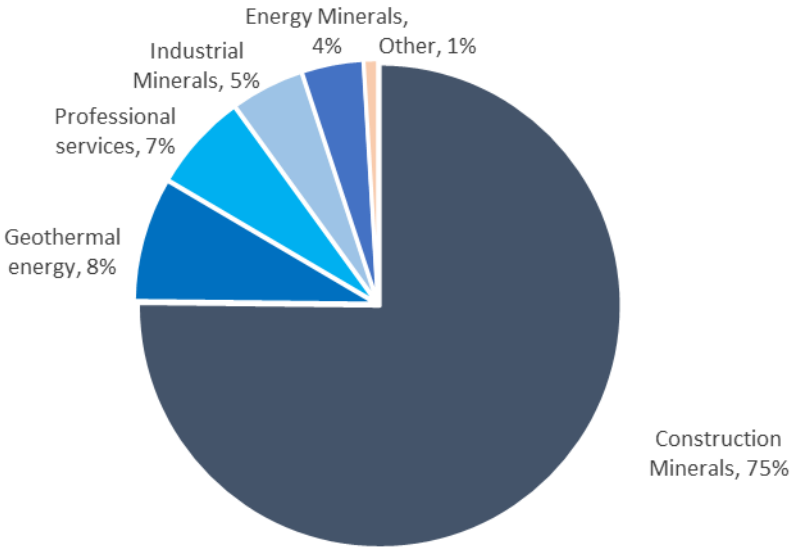
Sources: Business Register and Employment Survey (BRES) & UUEPC analysis

Since 2009, 2,400 jobs have been lost in the Construction Minerals sub-sector, 10% of its total. By contrast, the fastest growing subsector has been Energy Minerals, which has experienced growth of 77%, albeit from a low base and now represents just 690

jobs. The two other large sub-sectors, Geothermal Energy and Professional Services, have each added on around 500 jobs between 2009 and 2017.

Turning to aGVA, Figure 24 shows how the largest sub-sectoral category of the geoscience industry is Construction Minerals, this time accounting for 75% of total aGVA (£1.6 billion). Geothermal Energy and Professional Services come next, jointly accounting for less than 15% of the industry's total aGVA and less than 1% of NI's total GVA.

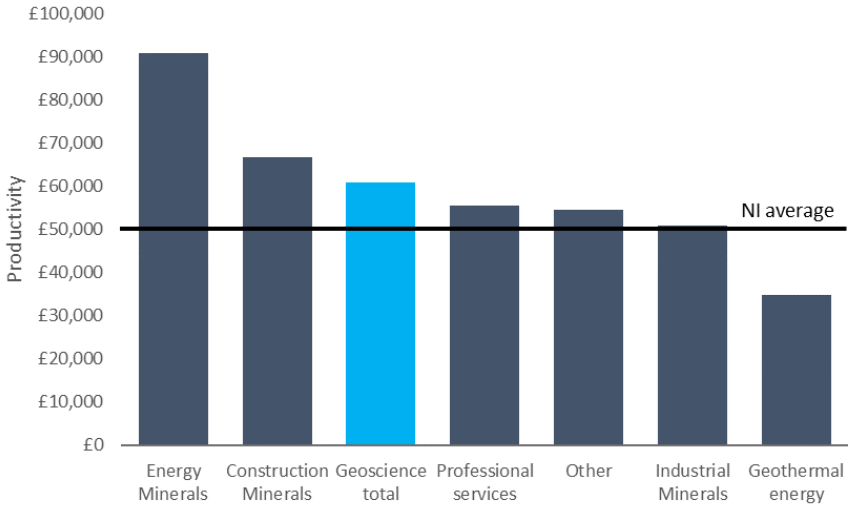
Figure 24: aGVA by geoscience sub-sector, % of geoscience total, 2016



Sources: NI Annual Business Inquiry, ONS & UUEPC analysis

Within an NI sectoral context, we found that the productivity of the geoscience industry performed above most sectors (see Figure 16). This is borne out for the geoscience sub-sectors in Figure 25 with all, bar Geothermal Energy, performing above average. Although Energy Minerals, one of the smallest sub-sectors, has the highest productivity, most sub-sectors are bunched above average suggesting a consistency through the industry. Data for comparing productivity between the NI and other UK regional sub-sectoral averages would give a clearer picture of where the overall gap might lie.

Figure 25: Productivity by geoscience sub-sector, 2015

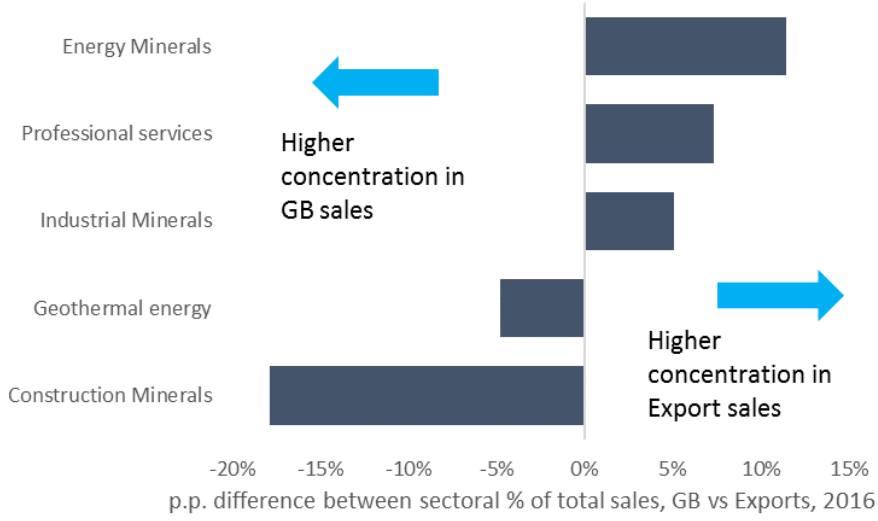


Sources: NI Annual Business Inquiry, ONS, Business Register and Employment Survey (BRES) & UUEPC analysis

Notes: GVA uses results from the 'balanced' approach

External sales by sub-sector reinforce the importance of the Construction Minerals subsector, which accounts for 75% of the total (£1.5bn). The same pattern exists to a lesser degree for exports, where Construction Minerals businesses account for 63% of the total (£570m). However, there is more diversity in exports than in sales to GB (see Figure 26), with a larger proportion of exports being attributed to firms in the Energy Minerals, Professional Services and Industrial Minerals sub-sectors.

Figure 26: Breakdown of geoscience sales by sub-sector, % of total sales, GB sales vs exports, NI, 2017

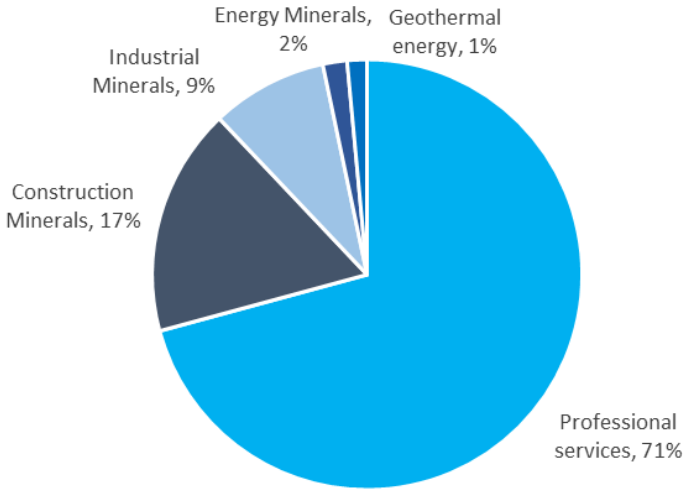


Sources: Broad Economy Sales and Exports Statistics (BESES) & UUEPC analysis

There is a very different sub-sectoral picture than before with core Professional Services businesses (£54m) the key performers (see Figure 27). Construction Minerals, consistently the largest geoscience sub-sector accounts for 17% of the industry's R&D.

This is not a one-off result for 2017 as the time series data show how Professional Services has consistently accounted for more than two thirds of the industry's BERD. This sub-sector includes environmental and engineering consultancy services – such as ARUP Consulting – which are well-known for engagement in EU-funded R&D programmes.

Figure 27: BERD (£M) by geoscience sub-sector, percentage of geoscience total, 2017



Sources: NI Research and Development Survey, NISRA & UUEPC analysis

According to GSNI figures, the Survey, along with university and business research partners, has leveraged £22m research funding from NI, UK, Irish and EU funders over the past 14 years. GSNI collaborate with 35 universities or research institutes across the world. One example of this is where GSNI, along with Queen's University Belfast, are currently building a new Chinese partnership to work together on clean, advanced and sustainable energy research. Additionally, GSNI is a member of and works closely with Geoscience Ireland, a network of 37 companies across the island of Ireland which deliver integrated expertise in water, minerals, environmental and infrastructure development to clients on over 50 countries. The network provides design, consultancy and contracting services to multilateral agencies, governments and the private sector.

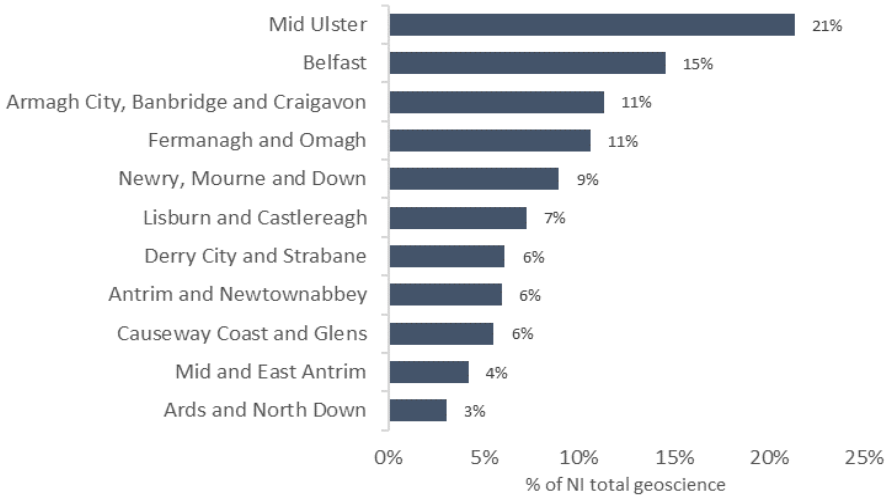
4.2 Sub-regional analysis: Jobs and firms are prominent in Mid-Ulster

The sub-regional analysis aims to provide a picture of the regional spread of the geoscience industry in NI, using the geography of Council areas.

In terms of geoscience jobs, Mid-Ulster has the largest share (21% of the total) within NI. Figure 28 shows how Mid Ulster accounts for 1.5 times that of the next largest LGD, Belfast at 15%. Mid Ulster has remained the location of the sector's largest employment share since 2009 and has increased its share significantly over the period, from 15% to 21%. The council area has a particular specialism in the materials handling sector,

with a large concentration of geoscience jobs within Mid-Ulster connected to the extraction of proximate extensive mineral resources. Two of the three main extraction areas for sand and gravel within NI are located in Mid-Ulster, on the eastern flank of the Sperrin Mountains and dredged from the bed of Lough Neagh. Mid Ulster is also one of three sites (the others in Fermanagh & Omagh and Derry City & Strabane) for valuable metalliferous minerals within three geological settings – the Pre-Cambrian Dalradian metamorphic rocks, the Tyrone Igneous Complex and Carboniferous sedimentary rocks.

Figure 28: Geoscience employees, percentage of NI sector total, NI LGDs, 2017

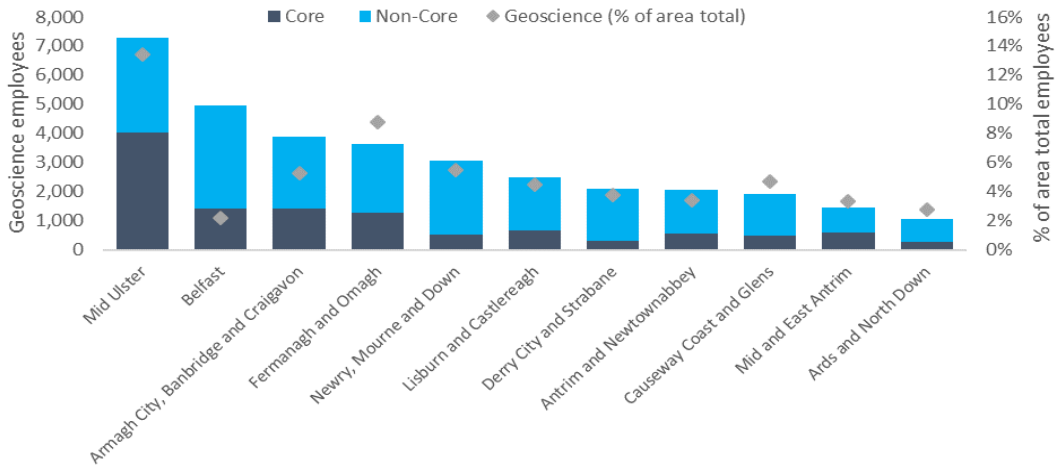


Sources: Business Register and Employment Survey (BRES) & UUEPC analysis

When the number of geoscience jobs are analysed taking into context the size of a local area's total workforce, geoscience is a significant employer in Mid-Ulster (13% of total jobs). Geoscience employment has grown within the Mid-Ulster area both in jobs terms (+44% since 2009) and as a proportion of total employment (11% to 13%). This continued even during the downturn - with the exception of 2009-2010.

A different picture is presented in other areas (see Figure 29). While Belfast has the largest number of geoscience jobs after Mid-Ulster, the sector represents just 2% of total employees in the city. Alternatively, Fermanagh and Omagh has the fourth largest concentration of jobs, and geoscience accounts for 9% of the total workforce.

Figure 29: Geoscience employees, total vs percentage of local area total, LGDs, 2017



Sources: Business Register and Employment Survey (BRES) & UUEPC analysis

The recent employment increase in Mid Ulster has been largely driven by the core sector, representing 92% of the job growth within the geoscience industry in the area[13]. However, Figure 29 shows that the non-core sector is the primary source of jobs within the geoscience industry in every other LGD. In Mid Ulster, 55% of jobs stem from core geoscience representing more than one third (35%) of all NI core jobs.

Table 1 provides more details on the different sub-sectors of the geoscience industry across the LGDs. (Industrial Minerals has a large amount of disclosive data, perhaps suggesting that most of its jobs are in two Council areas: Fermanagh & Omagh and Mid Ulster). Across all council areas (except Belfast), Construction Minerals accounts for more than half of the geoscience jobs by sub-sector. The dark blue shading denotes the largest proportion by a Council area, within each individual sub-sector categories.

[13] Note that the count of employee jobs can change due to a variety of reasons such as businesses opening/closing/recruiting/redundancies, as well as movement from one council area to another, or a reclassification of their standard industrial code (SIC)

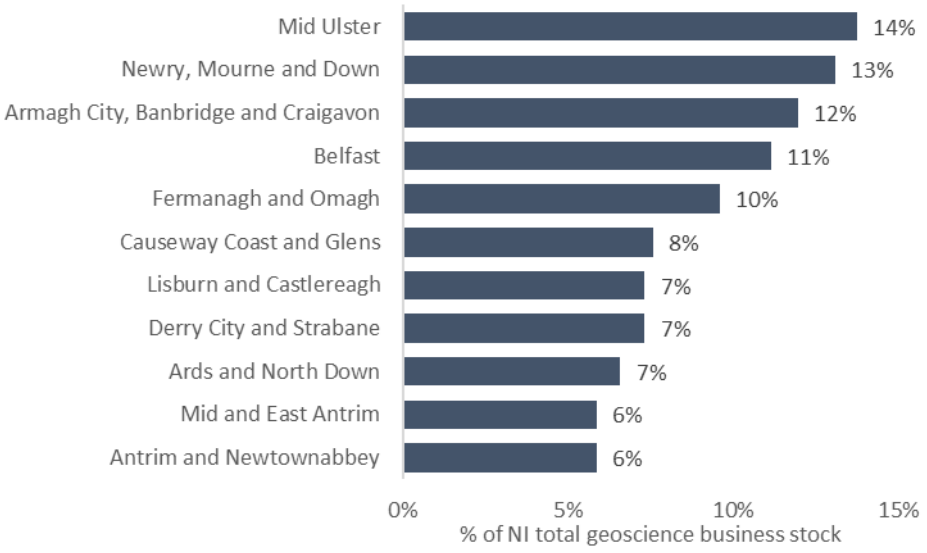
Table 1: Breakdown of geoscience employees by sub-sector categories, percentage of local area total geoscience, LGDs, 2017

Sector breakdown	Construction Minerals	Geothermal Energy	Industrial Minerals	Professional Services	Other geoscience
Antrim and Newtownabbey	65%	11%	*	7%	17%
Ards and North Down	67%	16%	*	12%	5%
ABC[14]	51%	13%	*	22%	14%
Belfast	35%	23%	*	26%	16%
Causeway Coast and Glens	84%	8%	*	3%	5%
Derry City and Strabane	61%	13%	*	5%	21%
Fermanagh and Omagh	74%	5%	14%	3%	4%
Lisburn and Castlereagh	76%	10%	*	10%	4%
Mid and East Antrim	70%	11%	*	11%	8%
Mid Ulster	70%	9%	13%	2%	6%
Newry, Mourne and Down	75%	16%	*	3%	6%
NI	64%	12%	7%	10%	7%

Sources: Business Register and Employment Survey (BRES) & UUEPC analysis
Note: Dark blue shading denotes the area which holds the highest concentration of jobs within sub-sector.

In addition to having the largest share of geoscience jobs, Mid Ulster also holds the largest share of geoscience business stock at 14% (lower than the 21% share of employment). Figure 30 shows that this share is closely followed by Newry, Mourne and Down at 13% (with a 9% share of total employees). The distribution of geoscience firms has not changed greatly since 2013, the first data point that is available. Key companies within Mid-Ulster that operate within the geoscience sector include Edge Innovate, CDE Global, Terex, Northstone and FP McCann.

Figure 30: Geoscience businesses, percentage of NI sector total, NI LGDs, 2017

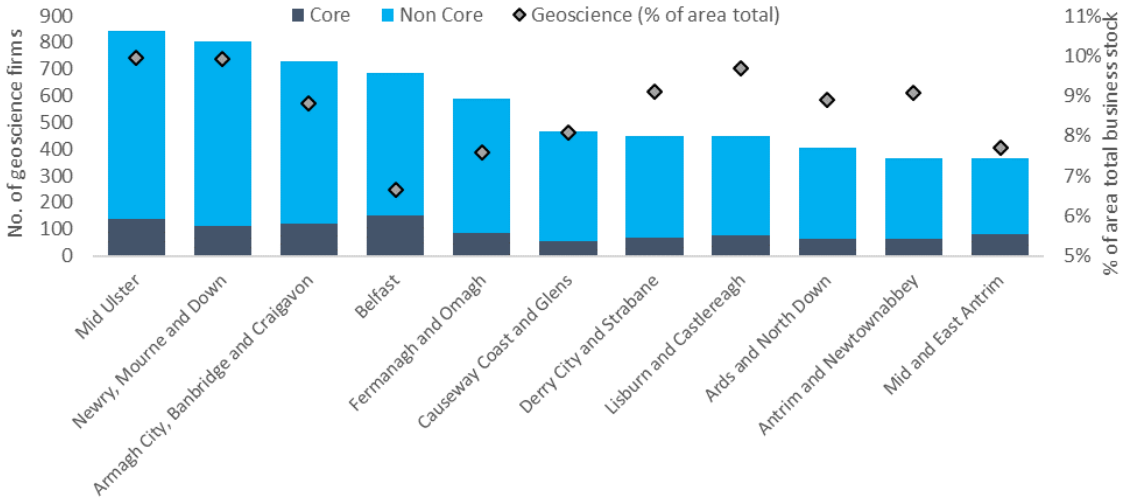


Sources: Inter-Departmental Business Register & UUEPC analysis

[14] Armagh, Banbridge and Craigavon

Figure 31 shows that Mid-Ulster is the LGD with the highest concentration of geoscience firms when analysed in relation to the overall business stock in the Council area. Belfast has the largest difference between the share of total NI geoscience firms compared with local stock (11% vs 7%). All LGD areas have a larger number of firms operating within the non-core subsector of the geoscience industry than within the core component.

Figure 31: Geoscience firms, total vs percentage of local area total, LGDs, 2017



Sources: Business Register and Employment Survey (BRES) & UUEPC analysis

Overall, the geoscience sector is of particular importance to the Mid-Ulster local economy. The sector directly provides more than 10% of all jobs within the area, and the number of geoscience jobs have been growing there in recent years. The council area has a significant mineral resource base, and one spillover of this has been the development of specialisms in the materials handling sector. The Mid-Ulster Council recognises the sector's significance in their local development plan[15], proposing to safeguard mineral reserves from surface development to ensure that existing business and future businesses may extract them; designate areas of mineral constraint to protect vulnerable landscapes; and facilitate mineral development in other locations within the council area.

Finally, in terms of R&D spend by LGD, the data are quite sparse and only allows for analysis of the predominant core geoscience BERD. Core geoscience businesses in Armagh, Banbridge & Craigavon spent around £34.4m on R&D in 2017, equivalent to 41% of the total geoscience BERD in NI. The Council area ranks third in terms of numbers of geoscience businesses, suggesting a concentration of investors in BERD. Not surprisingly, Mid Ulster is a strong performing LGD, accounting for 18% (£15m) of total geoscience BERD, while Belfast is ahead with 27% (£22.3m) of the total in 2017.

[15] Mid-Ulster-Local Development Plan 2030

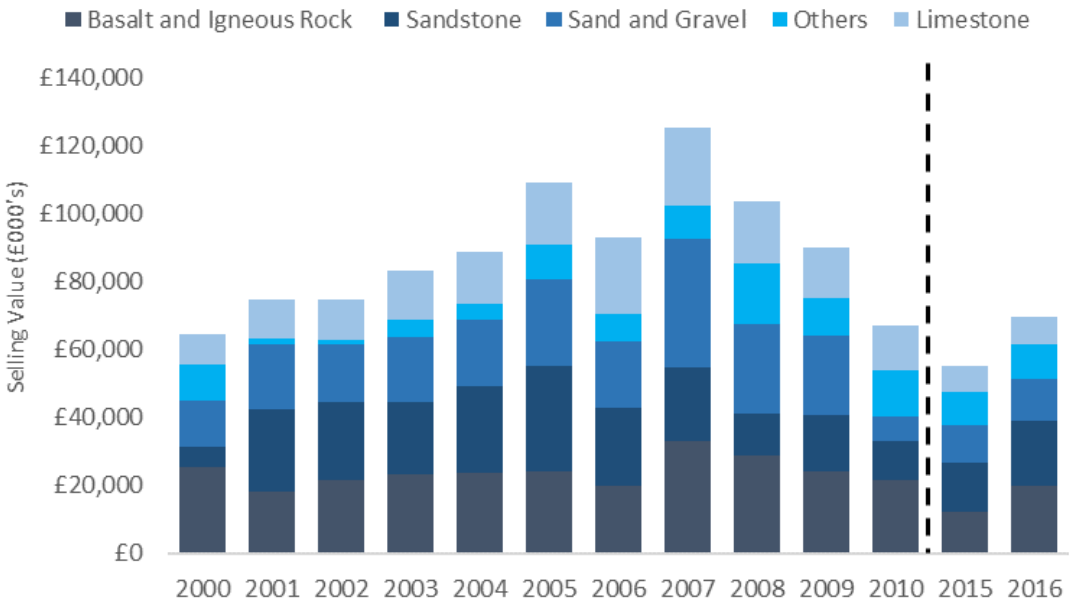
5. Minerals: Output and Values

This section of the report focuses on minerals which are a key component of the geoscience industry. Within NI, there are approximately 160 quarries, mines and sand pits. According to the Minerals Product Association Northern Ireland (MPANI), annual demand for aggregates within the region is approximately 24 million tonnes. The construction industry is heavily reliant upon mineral products as they are required in order to build new homes, buildings, schools and hospitals alongside maintenance of road and rail networks. It is estimated that nearly 14 tonnes of aggregates are needed per head of the population in NI, and that a typical family indirectly demands three lorry loads of aggregates each year.

In 2016, 15 million tonnes of minerals were produced in NI with a selling value (at the mine or quarry) of £69.7m. More than half (56%) of the total value was derived from the extraction of two products: Basalt & Igneous Rock (4.2 million tonnes worth £19.8m) and Sandstone (5 million tonnes worth £19.2m). Figure 32 shows how the mineral values peaked in 2007 with a total selling value of £125m. However, values since the recession have been in decline, only increasing again in the most recent year. During the period of 2007 to 2016, Sand & Gravel endured the biggest reductions in both production volumes and selling value. This mineral saw average annual declines of 12.8% and 11.8% respectively. Each mineral product has experienced a decline in production following the recession, except for Sandstone, with an average annual growth of 0.5%, though selling value fell by 1.3%.

In total, over the 9-year period, the value of minerals within NI has declined at an annual average rate of 6.3%, only slightly slower than the 7.2% annual decline in production.

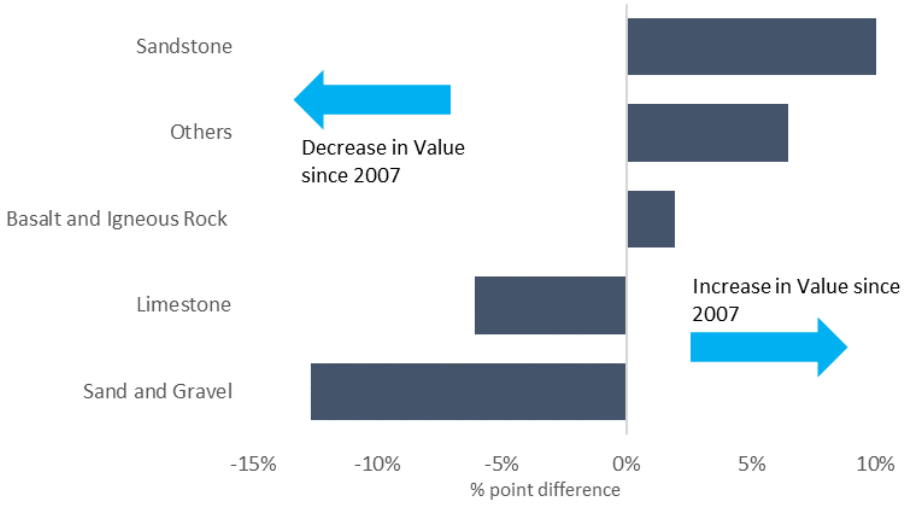
Figure 32: Selling Value of Minerals by Product, NI, 2000-2016



Sources DfE & UUEPC analysis
Note: The broken line indicates that robust data are not available for the years 2011 through to 2014

Figure 33 shows how, in comparison to the 2007 peak in selling values, Sandstone has had the largest increase rise in the contribution of total mineral value, increasing by 10 percentage points. The contribution of Sand & Gravel has had a large contraction of 13 percentage points, falling to 18% of the total mineral value in 2016. The impact of this fall is evident in the overall decline in total value given that the value per tonne for Sand & Gravel in both 2007 and 2016 was the highest relative to the other minerals (£4.70 and £5.20 per tonne respectively). Referring back to Figure 32, one can see the importance of Sand & Gravel in the peak value years of 2005-2008.

Figure 33: Difference in Contribution to Total Mineral Value, NI, 2007-2016



Sources: DfE & UUEPC analysis

Table 2 shows the relative contribution of minerals extraction and prices in NI compared to the UK. In 2015 the production of minerals within NI accounted for 3.7% of the UK's total production. In the same year, however, the selling value was just 0.2% of the UK's total. This can be explained by comparing NI to the UK on a price per tonne produced. NI is lower for each of the four comparable minerals. For example, NI's production of sandstone makes up 30% of the UK's, but only accounts for 11.3% of total selling value. This is a result of the price per tonne being 62% less than that of the UK average.

Table 2: Breakdown of Mineral Contribution relevant to the UK, NI, 2015

	% of UK total Production	% of UK total Value	UK Price per Tonne	NI Price per Tonne	% of UK price
Basalt and Igneous Rock	5.6%	3.4%	£7.60	£4.60	60%
Sandstone	29.9%	11.3%	£9.80	£3.70	38%
Limestone	2.3%	1.1%	£9.50	£4.50	47%
Sand and Gravel	3.9%	1.7%	£10.50	£4.40	42%

Sources: British Geological Survey, DfE & UUEPC analysis
Note: Due to a lack of NI data from 2011 through to 2015, UK values are estimated using 2014 figures.

Within NI each of the minerals produced has a dominant LGD. For example, Causeway Coast & Glens accounts for 29% of the total production of Basalt & Igneous rock, with total value accumulating to £5.8m. Almost two thirds (63%) of NI's Sand & Gravel is produced in pits in Mid Ulster, making a total value of £7.8m. Nearly half (47%) of Limestone production comes from quarries in Mid Ulster and Mid & East Antrim, at a value of £4m. Finally, Ards & North Down is the key place for Sandstone quarries, accounting for 35% of the total mineral produced with a value of £6.7m.

6. Summary and Conclusions

The geoscience industry or sector in Northern Ireland is both well-established and little-known. A wide variety of business activities, from the extraction and production of mineral products to the technical testing and engineering services, fall under the geoscience heading. Outcomes from geoscience research, such as care of groundwater and the development of energy resources (such as geothermal), also need to be recognised and, where possible, encouraged in NI or in partnership with actors on the island of Ireland or in other UK regions.

6.1 Value and scale of the industry

The UUEPC have calculated the full economic impact of the geoscience industry to the wider NI economy to be 83,700 jobs, £3.7 billion in GVA and £1.8 billion in wages. The respective Type II multipliers are 2.7, 1.9 and 2.5. These are all significant figures, equivalent to around 10% of the NI economy being directly or indirectly impacted by geosciences.

This economic value is understandable when the scale of the geoscience industry in NI is considered. The industry directly accounts for a total of 34,000 jobs (4.6% share of NI's total employment), aGVA of £2.1 billion (5.8% share of total NI GVA) and 6,150 businesses (8.6% share of the total). In terms of NI equivalents, the employment numbers are similar to the Agriculture sector and the knowledge economy and the aGVA total close to GVA produced by Construction.

The industry has higher levels of productivity than the NI average, with a 21% premium. Employees in the sector earn 9% higher than the NI average wage. This may be explained, in part, by the extent to which it is a capital-intensive industry.[16] Reflecting the high productivity levels geoscience has a significant share of business R&D, the firms most recently accounting for 15.5% (£84 million) of the total NI business expenditure on R&D (BERD). Geoscience firms are also more externally-focussed than the norm in NI with 43% of sales (£2.9 billion) going outside NI, most likely a mix of construction material for the GB and Republic of Ireland markets and materials handling equipment for several export markets.

Within the geoscience industry in NI there are two important concentrations to bear in mind. First, the industry has a large (and growing) concentration of both jobs and firms in the Mid Ulster council area related to extraction and manufacturing. Second, the Construction Minerals sub-sector is the dominant one within the industry.

[16] Capital intensity here refers to the higher ratio of capital goods (plant and machinery) to labour in the geoscience industry compared to other sectors.

6.2 Trends and Opportunities

While the scale and value of the geoscience industry have been established, the strategic importance of the sector to economic development in NI – as measured by its supporting rather than priority place in the Industrial Strategy – is open to discussion.

This research shows how the geoscience industry is intricately linked to the Construction sector more widely. In part, this is because almost three quarters of the minerals extracted (Basalt, Sandstone and Sand & Gravel) are used in building products, and general infrastructure projects, such as commercial buildings, road and railways. Although there are numerous licenses for prospecting and the value of the Curraghinalt deposit remains to be seen, in comparative terms NI is not currently a producer of large amounts of metals or industrial minerals.

This, in turn, explains the dominance of Construction Minerals within the industry and the sharp decline in jobs and wages in geoscience during the recession after 2008. This will create opportunities for the sector as construction activity in NI grows, albeit slowly and well behind the levels in neighbouring Ireland.

A second trend highlighted by the research is that when comparing the performance of the geoscience industry in NI to the UK average or to other UK regions, the picture is a mixed one. The NI industry has above average shares of employment and of business stock but is below UK averages for productivity and wages premia, and share of GVA. It is fair to say that geoscience is not alone among sectors and industries in NI in having below-UK-average productivity or wage levels. However, there are two differences between UK and NI geoscience which do stand out. The first is the values received for minerals extracted which are significantly lower than the UK averages (see Table 2). The reasons for this are not clear.[17] The second difference is the smaller, albeit growing, shares of employment and GVA enjoyed by core geoscience in the overall sector when compared to other UK regions. This may be a factor in lower productivity and further developing the core part of the geoscience industry appears to be important to the overall sector's health.

A third finding is that the sector is in growth mode. The core parts of the industry actually increased their levels of aGVA and the overall productivity premium increased to 31%. This perhaps speaks to the importance of mining and quarrying machinery to geoscience's performance and partly explains the concentration in Mid Ulster. This spillover effect from geoscience activities does highlight why continued oversight of the sector by the Department for the Economy is important.

Finally, as noted earlier in the report, the Department also has responsibility for another element sometimes found within research on geoscience – geotourism.[18] In NI some of the most popular visitor attractions – Giant's Causeway Visitor Centre, Marble Arch

[17] InterTradeIreland, *A competitive analysis of the construction materials sector on the island of Ireland – An update* (November 2015).
[18] See Indecon Economic Consultants, *An Economic Review of the Irish Geoscience Sector* (November 2017).

Caves, Silent Valley/Mournes and Slieve Gullion – are certainly at least partly regarded by tourists as geotourism attractions. All are currently or applying to become UNESCO GeoHeritage or GeoParks, and hopeful of accessing the supports and funding associated with this for the care and conservation of sites. Given that the four sites between them attracted more than 1.3 million visitors in 2017, a case can be made for geotourism and the yet-to-be established metalliferous development (noted above) being key opportunity areas for the wider geoscience activities in the future.

Annex A: Department for the Economy (DfE) Geoscience SIC 07 definition

The geoscience sector has been defined by the steering group agreeing on a list of relevant 2007 Standard Industrial Codes (SIC07) at the 5-digit level (the most detailed) to include in the geoscience sector.

Broad sector	Subsector	SIC07 code	SIC description
Core geoscience	Construction minerals	08110	Quarrying of ornamental and building stone; limestone; gypsum; chalk and slate
		08120	Operation of gravel and sand pits; mining of clays and kaolin
		23510	Manufacture of cement
		23520	Manufacture of lime and plaster
		23610	Manufacture of concrete products for construction purposes
		23620	Manufacture of plaster products for construction purposes
		23630	Manufacture of ready-mixed concrete
		23690	Manufacture of other articles of concrete; plaster and cement
		23700	Cutting; shaping and finishing of stone
		28922	Manufacture of machinery for mining; quarrying and construction
		28923	Manufacture of equipment for concrete crushing and screening and roadworks
		46630	Wholesale of mining; construction and civil engineering machinery
	Energy minerals	05101	Deep coal mines
		05102	Open cast coal working
		05200	Mining of lignite
		06100	Extraction of crude petroleum
		06200	Extraction of natural gas
		08920	Extraction and agglomeration of peat
		09100	Support activities for petroleum and natural gas extraction
	Groundwater	38220	Treatment and disposal of hazardous waste
		43130	Test drilling and boring
	Industrial minerals	08910	Mining of chemical and fertilizer minerals
		08930	Extraction of salt
		08990	Other mining and quarrying n.e.c.
		09900	Support activities for other mining and quarrying
		23640	Manufacture of mortars
		23650	Manufacture of fibre cement
		23990	Manufacture of other non-metallic mineral products n.e.c.
		28921	Manufacture of machinery for mining

	Metals	07100	Mining of iron ores
		07210	Mining of uranium and thorium ores
		07290	Mining of other non-ferrous metal ores
		24410	Precious metals production
		24420	Aluminium production
		24430	Lead; zinc and tin production
		24440	Copper production
		24450	Other non-ferrous metal production
	Professional services	71122	Engineering related scientific and technical consulting activities
		71200	Technical testing and analysis
		72190	Other research and experimental development on natural sciences and engineering
		74901	Environmental consulting activities
		74909	Other professional; scientific and technical activities n.e.c.
Non-core geoscience	Construction minerals	41100	Development of building projects
		41201	Construction of commercial buildings
		41202	Construction of domestic buildings
		42110	Construction of roads and motorways
		42120	Construction of railways and underground railways
		42130	Construction of bridges and tunnels
		42990	Construction of other civil engineering projects n.e.c.
		43120	Site preparation
	Energy minerals	20160	Manufacture of plastics in primary forms
		20170	Manufacture of synthetic rubber in primary forms
	Geothermal energy	43220	Plumbing; heat and air-conditioning installation
	Groundwater	42910	Construction of water projects
	Industrial minerals	20301	Manufacture of paints; varnishes and similar coatings; mastics and sealants
		20302	Manufacture of printing ink
		23110	Manufacture of flat glass
		23120	Shaping and processing of flat glass
		23130	Manufacture of hollow glass
		23140	Manufacture of glass fibres
		23190	Manufacture and processing of other glass; including technical glassware
		23910	Production of abrasive products
	Metals	24310	Cold drawing of bars
		24320	Cold rolling of narrow strip
		24330	Cold forming or folding
		24340	Cold drawing of wire
	Underground energy storage	42210	Construction of utility projects for fluids
		42220	Construction of utility projects for electricity and telecommunications

Annex B: Calculating economic impact

The overall impact of the geoscience industry on the NI economy is calculated in three steps:

1. Step 1 is to calculate the ***direct*** impacts of the geoscience sector using data supplied by NISRA for 2015. This year has been used as it is the last year of data where official statistics provide values for employment, economic output and GVA. There is official GVA and output for 2016, but the Business Register and Employment Survey (BRES) is biannual so employment data is only available for 2015 and 2017.

2. Step 2 is to calculate the ***indirect*** and ***induced*** impacts. The ***indirect*** (supply chain) effects are calculated using a 'Type II' input-output model (derived from Scotland's Input-Output tables) alongside the UUEPC NI model.[19] Location quotient analysis has been used to account for leakage effects (ie: the share which is likely to have accrued outside of the NI economy). The ***induced*** (spending) effects have been calculated by using the experimental NI input/output tables in order to identify and allocate to the sectors where additional wages are likely to be spent. Again, location quotient analysis has been used to account for leakage outside the NI economy, although it is expected this will be less than in the case of the supply chain effects. For both effects Output is generated in these steps.

3. The data collected in Steps 1 and 2 is then collated to ascertain the total net economic impact of geoscience on the NI economy. The data provides an estimate of Output, which is converted into GVA using the NI Annual Business Inquiry output/GVA sectoral ratios. GVA is then converted into jobs using sectoral productivity figures. This results in output, GVA and jobs (and the associated wage) figures which are the economic impacts attributable to the geoscience industry.

[19] The Scottish Input-Output tables will be used rather than UK Input-Output tables, as these regional tables are more likely to mimic spending behaviours within the NI economy. UUEPC prefer to use the tested Scottish tables over the currently experimental NI Input-Output model.

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