

The Introductory Reader in
Human Geography:
Contemporary Debates and Classic Writings

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Contents

List of Figures	xi
Notes on the Editors	xiii
Preface and Acknowledgments	xiv
Introduction: Situating Human Geography	1
<i>William G. Moseley, David A. Lanegran, and Karita Pandit</i>	
Part I: Introductory Readings	11
Introduction	13
<i>William G. Moseley and David A. Lanegran</i>	
1 The Four Traditions of Geography	16
<i>William D. Pattison</i>	
2 Geography's Perspectives	22
<i>National Research Council</i>	
3 Geography and Foreign Policy	37
<i>H. J. de Blij</i>	
4 Reflections of an American Geographer on the Anniversary of September 11th	39
<i>William G. Moseley</i>	
5 How to Lie with Maps	42
<i>Mark Monmonier</i>	
6 Every Step You Take, Every Move You Make	46
<i>Jerome E. Dobson</i>	

Part II: Population and Migration	49
Introduction	51
<i>William G. Moseley and Kavita Pandit</i>	
7 An Essay on the Principle of Population	54
<i>Thomas Robert Malthus</i>	
8 Population Growth and a Sustainable Environment	65
<i>Michael Mortimore and Mary Tiffen</i>	
9 Population Geography and HIV/AIDS: The Challenge of a "Wholly Exceptional Disease"	81
<i>W. T. S. Gould and R. I. Woods</i>	
10 Interprovincial Migration, Population Redistribution, and Regional Development in China: 1990 and 2000 Census Comparisons	96
<i>C. Cindy Fan</i>	
Part III: Environment, Agriculture, and Society	111
Introduction	113
<i>William G. Moseley</i>	
11 The Worst Mistake in the History of the Human Race	116
<i>Jared Diamond</i>	
12 The Future of Traditional Agriculture	122
<i>Donald Q. Innis</i>	
13 Geography and the Global Environment	132
<i>Diana M. Liverman</i>	
14 Water Resource Conflicts in the Middle East	142
<i>Christine Drake</i>	
15 Americans and Their Weather	156
<i>William B. Meyer</i>	
16 The Trouble with Wilderness; or, Getting Back to the Wrong Nature	167
<i>William Cronon</i>	
Part IV: Cultural Geography and Place	179
Introduction	181
<i>David A. Lanegran</i>	
17 Minnesota: Nature's Playground	184
<i>David A. Lanegran</i>	

18 American Microbreweries and Neolocalism: "Ale-ing" for a Sense of Place	198
<i>Wes Flack</i>	
19 Transplanting Pilgrimage Traditions in the Americas	206
<i>Carolyn V. Prorok</i>	
20 Kitchenspace, Fiestas, and Cultural Reproduction in Mexican House-Lot Gardens	221
<i>Maria Elisa Christie</i>	
Part V: Urban Geography	233
Introduction	235
<i>David A. Lanegran</i>	
21 Greenville: From Back Country to Forefront	238
<i>Eugene A. Kennedy</i>	
22 Ethnic Residential Concentrations in United States Metropolitan Areas	247
<i>James P. Allen and Eugene Turner</i>	
23 South Africa's National Housing Subsidy Program and Apartheid's Urban Legacy	264
<i>Kimberly Lanegran and David Lanegran</i>	
24 World-City Network: A New Metageography?	279
<i>Jonathan V. Beaverstock, Richard G. Smith, and Peter J. Taylor</i>	
Part VI: Economic Geography	291
Introduction	293
<i>William G. Moseley</i>	
25 Geographies of Knowledge, Practices of Globalization: Learning from the Oil Exploration and Production Industry	296
<i>Gavin Bridge and Andrew Wood</i>	
26 The Impact of Containerization on Work on the New York-New Jersey Waterfront	306
<i>Andrew Herod</i>	
27 Wine, Spirits, and Beer: World Patterns of Consumption	310
<i>David Grigg</i>	

28	Producing and Consuming Chemicals: The Moral Economy of the American Lawn <i>Paul Robbins and Julie T. Sharp</i>	323
29	Women at Work <i>Mona Domosh and Joni Seager</i>	337
Part VII: The Geography of Development and Underdevelopment		349
	Introduction <i>William G. Moseley and Kavita Pandit</i>	351
30	The Re-scaling of Uneven Development in Ghana and India <i>Richard Grant and Jan Nijman</i>	354
31	Development Alternatives: Practice, Dilemmas, and Theory <i>A. J. Bebbington and D. H. Bebbington</i>	369
32	Rural Development in El Hatillo, Nicaragua: Gender, Neoliberalism, and Environmental Risk <i>Julie Cupples</i>	381
33	The Sahel of West Africa: A Place for Geographers? <i>Simon Batterbury</i>	395
34	Geography, Culture, and Prosperity <i>Andres Oppenheimer</i>	400
Part VIII: Political Geography		403
	Introduction <i>David A. Lanegran</i>	405
35	Revisiting the "Pivot": The Influence of Halford Mackinder on Analysis of Uzbekistan's International Relations <i>Nick Megoran</i>	408
36	Euroregions in Comparative Perspective: Differential Implications for Europe's Borderlands <i>Joanna M. M. Kepka and Alexander B. Murphy</i>	422
37	The End of Public Space? People's Park, Definitions of the Public, and Democracy <i>Don Mitchell</i>	437
	Index	449

Figures

0.1	Distribution of maize production in the world	6
2.1	The matrix of geographic perspectives	23
8.1	Population distribution in the Machakos District of Kenya in 1932 and 1979	66
8.2	The recorded output of four market crops in the Machakos District from 1963 to 1988	72
8.3	The farm output of the Machakos District from 1930 to 1987 in constant 1957 maize prices	77
9.1	Estimated proportion of adults HIV+, Africa, 2002	85
9.2	Projected age and sex structure and AIDS deaths, South Africa, 2009	88
10.1	Provincial-level units and the three regions (China)	103
10.2	Regional distribution and inequality of GDP per capita, 1985–2001	103
10.3	Prominent interprovincial net migration flows, 1985–1990	106
10.4	Prominent interprovincial net migration flows, 1995–2000	107
14.1	The Tigris-Euphrates basin	147
14.2	The Nile basin	149
14.3	The Jordan-Yarmuk basin	150
21.1	Greenville County, South Carolina	241
23.1	Map of built-up districts of George (South Africa)	271
23.2	Street pattern of Pacaltsdorp and Thembaletu	276
24.1	Shared presences, primary vectors, and secondary vectors among Alpha world cities	285
24.2	World city links to London	286
27.1	The leading alcoholic beverage, 1997–9	313
27.2	The consumption of wine, litres per adult of absolute alcohol per year, 1997–9	314

Chapter 25

Geographies of Knowledge, Practices of Globalization: Learning from the Oil Exploration and Production Industry

Gavin Bridge and Andrew Wood

Globalization and the Knowledge Economy

The concept of *globalization* has emerged as a central theme within geography and the social sciences over the last decade. Contemporary research by economic geographers is largely critical of orthodox accounts, which tend to portray globalization as a systemic and inevitable force. To challenge conventional representations, a number of economic geographers recently have turned attention to the *practices* that constitute globalization and, in particular, to the ways in which firms achieve global reach. These studies frame global reach as a strategic challenge – a set of practices that must be initiated, developed and maintained over time if firms are to ‘go global’ – and begin to map the networks of actors and institutions that enable firms to successfully operate in diverse, often unfamiliar environments. Although still emerging, such critical ‘mappings’ of globalization capture the contingencies and complexities of achieving global reach.

At the same time, the last decade has also seen a proliferation of popular and scholarly literature on the ‘knowledge economy’. Much of this literature asserts that knowledge has become increasingly significant as an economic resource and that ‘the ability of labour, firms, regions and nations to produce, circulate and apply knowledge is fundamental to economic growth and competitiveness’. Evidence for the emergence of distinctive ‘knowledge economies’ frequently turns on the rise of knowledge-intensive sectors, the reshuffling of the division of labour to create a class of ‘knowledge-workers’, and a relative shift in the significance of knowledge vis-à-vis raw materials, capital or labour, as a factor of production.

Bridge, Gavin and Wood, Andrew, “Geographies of Knowledge, Practices of Globalization: Learning from the Oil Exploration and Production Industry,” pp. 199–207 from *Area*, 37.2 (2005).

Yet these two literatures and the key concepts that underpin them are rarely coupled. While work on economic globalization addresses the stretching of commodity chains and/or the integration of cities, regions and national economies into transnational networks, the role of knowledge in enabling and structuring these geographies of globalization is rarely considered. Similarly, geographical research on the knowledge economy has – until very recently – adopted the local scale as its primary entry point: in work on spatial clustering and learning regions, for example, the analytical claim that knowledge is socially embedded has tended to equate embeddedness with spatial proximity, neglecting the ways in which knowledge is acquired, developed and mobilized in the context of transnational economic networks. We argue that there is an opportunity here to critically harness these two bodies of work to (1) understand how and where different types of knowledge are produced, acquired and mobilized by firms as they seek to ‘go global’ and (2) to examine the ways in which these *networks of knowledge* structure emerging geographies of production, by influencing the ability of firms to integrate operations from socio-economically and geopolitically diverse environments into coherent production networks. In this paper we use the example of the oil industry – specifically oil exploration and production (E&P) – to illustrate how work on knowledge and knowledge economies might be deployed in developing a fuller understanding of the ways in which transnational firms construct and maintain global production networks.

[. . .]

The Oil Exploration and Production Industry as Empirical Context

On the face of it, the oil industry would appear to be an established, stable and mature industry with relatively little scope for radical innovation via the harnessing and mobilization of new forms of knowledge. Yet *technological change* (e.g. new subsurface imaging and visualization techniques), *organizational restructuring* (e.g. mergers, corporate downsizing, outsourcing and the emergence of niche markets for specialist firms), and the emergence of *new geographical opportunities* (e.g. exploration in non-traditional locales, such as the deepwater Gulf of Mexico, offshore China and West Africa, or in transition economies like Russia, Kazakhstan and Angola) are driving a re-evaluation of the way knowledge is produced, valued, communicated and harnessed within the industry. Anecdotal evidence suggests that in turn the ability to acquire, process and channel knowledge along the production chain is critically significant for the competitive position of oil producers. According to some observers, competitive success is now determined less by the marginal costs of extracting raw materials than by access to, and ability to use, knowledge. As one commentator recently put it, ‘knowledge, not petroleum, is becoming the critical resource in the oil business’.

In addition to being knowledge-intensive and knowledge-driven, E&P is also the most knowledge-extensive phase of the commodity chain, meaning that a wide range of knowledge types must be deployed, coordinated and integrated in order to locate and develop an oil reservoir. Whether in Ecuador or California, successful

development of an oil reservoir requires that knowledge relating to hydrodynamics, sedimentology and petrophysics be integrated with knowledge related to drilling targets, well planning and the estimation of completion costs, and that these in turn be integrated with knowledge associated with securing land rights, evaluating social and environmental risk, and community relations. Knowledge relating to E&P is then integrated with a set of more directly economic knowledges concerning market conditions, forecasts, logistics that also extend to the downstream phases of the production chain. The knowledge environment surrounding E&P is currently being radically reworked as a result of technological, organizational and geographical shifts in the way production is organized. Thus the structure of the exploration and production business in the 1990s was

turned on its head... the pigeon-holed, assembly-line approach of geoscientists studying data and generating prospects, and then handing them over to drilling engineers... gave way to an integrated team approach, from authoring a play through enhanced recovery.

While cautious of the normative tone running through much of this management-oriented literature, we find such descriptions highly suggestive for what they say about an emergent knowledge economy (and geography) within the oil industry.

Restructuring in the Oil Industry: The Role of Knowledge in Enabling Global Reach

The past is not prologue. New forces are re-shaping the energy industry's structure, its organisation, and markets, driving it toward a future that will be very different from anything it has ever seen. (Oil and Gas Journal 2001, 8)

Despite their tendency towards hyperbole, such assessments indicate that the oil industry is currently undergoing changes that are interlinked, relatively complex and potentially far-reaching. We identify three primary shifts: (1) historic reductions in production and exploration costs; (2) the opening up of new geographical opportunities, increasing the number and complexity of regulatory environments and exposing firms to new forms of investment risk; and (3) organizational restructuring, including both merger activity and an increased use of outsourcing. Table 25.1 summarizes each of the changes, and outlines working hypotheses linking them to the acquisition and mobilization of knowledge. We examine each in turn, paying particular attention to their implications for the geographies of knowledge within the industry.

Reductions in production and exploration costs

Understanding the role of knowledge in enabling global reach requires moving beyond technical knowledge to capture the full breadth and diversity of knowledge

Table 25.1 A matrix of positioning within the oil and gas industry and a preliminary assessment of the significance of different types of knowledge

Metric of change	Posited relationship between knowledge and metric of change	Posited relationship to geographies of knowledge
COSTS		
Decrease in production ('lifting') costs and exploration ('finding') costs	- Declining costs result from improvements in fundamental geological and petrophysical knowledge (e.g. depositional processes, reservoir mechanics, geophysics, stratigraphy and petrophysics) - Enabled via enhanced technical knowledge (e.g. computational mathematics, statistics and visualization) which have improved subsurface imaging and drilling accuracy - Increased salience of non-geological knowledge in managing investment risk - Demand for new types of knowledge associated with managing mineral rights/resource access, navigating regulatory frameworks and politics, and managing the social and environmental aspects of development - Increased significance of 'soft' (i.e. social/cultural) types of knowledge (vs. 'hard' technical or geophysical knowledge) - Re-evaluation of strategic significance of different types of knowledge - Changes in technical knowledge requirements create opportunities for new market entrants around specialized knowledge sets - Stratification of knowledge within the industry as firms recognize which types of knowledge are core assets and which can be outsourced	- Regionally based knowledge and experience (e.g. knowledge of a particular oil field, trend or play) now less valuable than knowledge of geological/petrophysical fundamentals - May indicate a shift towards de-territorialized/portable forms of knowledge - Shift in the knowledge-base may facilitate the globalization of oil exploration and production by US firms 'Local', place-specific knowledge increasingly important to the success of globalization strategies - Question of how best to acquire and develop these new types of knowledge: should it be 'produced' within the firm or acquired via contract? To what extent can aspects of soft knowledge be globalized? - Organizational knowledge network increasingly complex: organizational decentralization of knowledge/expertise via outsourcing, occurring simultaneously with organizational and geographic centralization in majors - Organizational complexity increases the significance of certain nodes within the knowledge network at expense of others, e.g. emergence of 'super-node' in Houston vs. second and third tier oil capitals
INVESTMENT ENVIRONMENT		
Increase in number and complexity of regulatory environments		
Increase in the significance of environmental and social performance as components of investment risk		
ORGANIZATIONAL STRUCTURE		
Increased outsourcing, changing role for smaller companies in partnerships/strategic alliances with majors and major suppliers		

flows within the industry. Changes in technical knowledge can, however, radically affect the value of other types of knowledge: improvements in drill rig design which enable production in greater depths of water, for example, or enhancements to seismic analysis enabling the identification of oil reservoirs below salt layers, have driven interest among oil producers in acquiring deepwater and sub-salt acreage. This, in turn, has created demand for the knowledge necessary to design optimum acreage acquisition strategies or to determine the relative risk/reward ratios of exploring traditional and non-traditional plays.

Recent innovations in the technology of oil exploration and production are best characterized as involving incremental rather than radical change. Yet because many innovations are interlocking, their cumulative effect has been a dramatic reduction in finding and producing costs. Improvements in data processing capability, for example, have made 3-D seismic imaging and analysis cost and time efficient for many applications. 3-D seismic technology enables geologists to construct three-dimensional images of the earth beneath the surface *before* drilling. Between 1985 and 1996, the percentage of wells drilled using 3-D seismic imaging in the Gulf of Mexico increased from 5 per cent to 80 per cent, while over the same period the success rate of exploratory wells increased from 36 per cent to 51 per cent. By increasing the accuracy of drilling targets, 3-D seismic imaging has in turn improved the economics of directional drilling and measurement-while-drilling, both of which have seen an increase in applications. The net result of these changes is that the costs of producing oil (known as 'lifting costs') and the costs of adding reserves (known as 'finding costs') have declined. Domestic lifting costs in the US in 1997 were 38 per cent *below* their level in 1986, when adjusted for inflation, while finding costs fell by 54 per cent over the same period. The overall effect is that the volume of oil discovered per well drilled is six times greater at the end of the 1990s than a decade earlier.

A number of commentators have argued that such dramatic changes amount to a definitive transformation in the industry:

Finding and producing oil is still about poking holes in the ground and bottling what comes out . . . In a number of respects, however, the oil business has begun to behave more like the New Economy than the Old. It is in the midst of the sort of technological change that (former US Treasury Secretary Lawrence) Summers compared to an avalanche; and the bang that started the avalanche came not from the oil fields but from Silicon Valley.

While appealing in their breadth and simplicity, such claims tend to conflate knowledge with data or information and assume a simple linkage between technology and knowledge production. Technologies like 3-D seismic imaging, horizontal drilling and monitoring-while-drilling are clearly transforming the quantity and quality of information available to the industry. However, the extent to which increases in information imply quantitative and qualitative changes in *knowledge production* remains to be determined. It is certainly possible that a fundamental shift in the significance and value attached to specific types of knowledge may drive changes in the geographies of knowledge and knowledge production within the

industry. For example, advances in data processing in the last few decades have driven a shift towards exploration based on understanding and modelling basic principles, as opposed to exploration via reference to regional analogues (i.e. by modelling existing oil reserves in the same region). In this case, technological change has tended to reduce the value of place-based, regionally specific knowledge accumulated over time, and has increased the portability (i.e. geographical mobility) of the knowledge sets necessary to develop oil reserves.

This is particularly intriguing in the context of recent work on the geographies of the knowledge economy which has commonly focused on place-based or 'territorialized' forms of knowledge and knowledge flows. Preliminary evidence suggests that in the oil sector the geographies of knowledge are considerably more complex than this position allows. While organizational restructuring may increasingly territorialize or embed the production of knowledge within specific urban nodes like Houston or Aberdeen, technological changes are simultaneously making the requisite knowledge that enables oil exploration *less* place-bound by abstracting it from the actual sites of extraction. In this particular knowledge economy, it would seem that geography matters both more *and* less.

Emergence of new regulatory environments and new forms of political risk

*There are more companies than ever before seeking opportunities worldwide,
and never have so many countries been open for business. (Oil and Gas Journal
1999, 16)*

While the major oil producers have long had an international presence, the past decade has witnessed a diversification of global exploration following the liberalization of investment regimes in many developing countries. Over 90 countries have revised their investment and mineral exploration laws to encourage foreign investment since 1985, opening up highly promising basins that were previously inaccessible to international oil companies either because of *de jure* political restrictions (e.g. Venezuela, Russia), or because political-economic risk was sufficiently high to deter prudent investment (e.g. Sudan, Angola). Of the 40–50 countries that currently grant exploration rights each year, nearly one-third were not even 'open for business' ten years ago. Thus, in the last 15 years US oil companies have more than doubled foreign exploration and development spending, while non-US oil majors, such as BP and Shell, have engaged in similar strategies. Because the largest oil firms are now active in a diverse set of socio-political contexts – and, therefore, must negotiate access to resources across a range of different regulatory environments – specific local and regional knowledge has become increasingly important as a way of managing investment risk.

In addition, technological advances (particularly those relating to deepwater offshore and sub-salt exploration) have opened up new physiographic environments to oil producers. Deepwater is now a major focus of worldwide exploration, particularly in the Gulf of Mexico and on either side of the South Atlantic. Because these environments traditionally have not been regarded as economically viable

resource areas, the regulatory frameworks governing resource access are evolving rather than well-established, especially when compared to more conventional, land or near-shore environments. For example, the federal Minerals Management Service (MMS) – which governs access to oil resources in the offshore Gulf of Mexico by auctioning mineral leases – has experimented in the last few years with incentives to encourage deepwater leasing. The 1995 passage of the Deep Water Royalty Relief Act, for example, led to record leasing rates in subsequent years: whereas only 17 per cent of leases issued in 1994 were in deep water, 70 per cent were in deep water in 1997. The evolving nature of these regulatory environments means that both regulatory agencies and oil firms are in a learning phase, in which the relative significance of conventional and new forms of knowledge (relating, for example, to optimum bidding strategies and risk assessment) are being constantly evaluated.

Venturing into non-traditional regulatory environments can introduce significant new forms of investment risk for oil firms. The general 'retreat of the national state' from direct intervention in the economy has, in many cases, created a dynamic and at times uncertain political environment in which the relationship between the central state and its regions is renegotiated. Oil firms making investments in emerging markets, therefore, enter a political environment in which different tiers of government (national, regional, local) compete for a measure of control over investment. Oil and gas producers on the Indonesian island of Sumatra, for example, find themselves in the middle of a regional separatist struggle against the central Indonesian state, in which contracts concluded at one administrative level and/or geographical scale of authority (e.g. at the national scale) are not respected at other levels (e.g. within the Sumatran province of Aceh). As oil firms operating from Ecuador to Russia have found out, sub-national governments (i.e. local and regional authorities) have increasingly attempted to tax or otherwise control oil production in – and oil transportation through – their territories during the 1990s as part of domestic political struggles to redefine the territorial authority of the state. Entry into 'emerging markets', therefore, places a premium on types of knowledge that are able to bridge between a firm's global investment strategies and its ability to implement those strategies in particular places. This strongly suggests a renewed emphasis on 'local', place-specific forms of knowledge, particularly knowledge about the legal and political environment in which firms seek to operate, as well as 'softer' forms of knowledge about the practical, socio-cultural 'know how' of getting things done in unfamiliar places. How firms form, trap, integrate and deploy such place-specific knowledge within the organization is a strategic challenge that lies at the heart of transnational firms' efforts to be simultaneously global and local.

Further, by increasing the openness of a national economy, policies of economic (and political) liberalization expose firms to increased demands for – and scrutiny of – standards of social and environmental performance. Boycotts and shareholder resolutions against Shell over its involvement in Nigeria, high-profile inquiries about the environmental and cultural impacts of foreign oil operations in Ecuador, and the political activities of civil organizations like Greenpeace more generally, demonstrate how issues of environmental and social risk have largely supplanted earlier concerns about national sovereignty, working conditions or the interregional

transfer of resource rents as primary challenges to the investment strategies of multinational resource firms in the developing world. Established mechanisms adopted by oil firms for accessing land, compensating landowners, and mitigating social and environmental impacts are increasingly insufficient for securing access to mineral deposits and bringing them into production. Resource firms increasingly seek advice from, and form strategic partnerships with, non-traditional sources of knowledge – including anthropologists, international development agencies, community dispute resolution specialists and experts in environmental communications – in order to successfully access, and remain active in, new environments.

Organizational restructuring

The global oil industry consists of large multinational integrated companies (the 'majors') encompassing all operating aspects of the industry, state-controlled companies in a number of oil-rich nations and a much more diverse group of firms specializing in upstream (exploration and development), midstream (processing and transportation) or downstream (refining and marketing) aspects. Over the last few years, these smaller companies have gained a larger role, especially within the US industry: for example, oil production by non-majors in the lower 48 onshore fields has exceeded that of majors since 1990. Yet the increasing role for non-majors within the US oil sector, or indeed in the UK, is taking place against a backdrop of mega-mergers among the largest firms (e.g. Exxon and Mobil in 1999; BP-Amoco and ARCO in 1999; TotalFina and Elf in 2000; Chevron and Texaco in 2001; Conoco and Phillips in 2001). This double movement suggests that the relationship between knowledge production and organizational form is a complex one. One possible explanation is that the knowledge sets associated with technological advances not only create opportunities for new market entrants, but also lead to a process of organizational sorting as firms recognize which knowledge types are key assets and which can be outsourced. This outsourcing of specialized functions and activities helps to account, at least in part, for the reduction in corporate research and development spending attributable to the majors. In terms of production, however, while smaller companies tend to drill less extensive fields and have faster depletion rates than the majors, their access to advanced technologies enables them to reduce finding costs close to those of the majors. Thus the availability of these technologies to smaller companies has

liberat(ed) them from the need to operate only on familiar territory because they know the geology and accompanying quirks. Access to technology opened up the whole world as an exploratory arena for most any size company with astute management.

Despite the geographic spread of their interests and activities, US oil exploration and production firms are remarkably concentrated in a small number of urban nodes (e.g. Houston, TX; Tulsa, OK; LaFayette, LA). Houston, for example, has emerged as a global centre of excellence for deepwater exploration and

development, and its dense networks of key institutions and individuals provide the means by which industry-specific knowledges are generated and circulated. As an industrial cluster of upstream oil producers and headquarter operations, Houston has consolidated its position as a key knowledge node: thus, companies 'locate (in Houston) so they can plug into cutting-edge activity and be part of the industry's knowledge loop'.

Recent research by economic geographers (and others) on the organization of the oil industry has tended to work within a regional development/learning region tradition: work by Chapman, Cumbers, MacKinnon and others in Scotland, and Feagin in the US, examines the regional development impacts of the oil industry in and around the key nodes of Aberdeen and Houston, respectively. While these studies provide valuable insight into the ways in which innovations are generated within key knowledge nodes or clusters, understanding the geographies of knowledge in the oil industry – an industry that is currently intensifying its global reach – requires a focus on both localized nodes and the more extensive (global) networks within which these local nodes are embedded. To focus exclusively on the region (e.g. Houston), for example, is to miss much of what makes the knowledge economy significant in an era of globalization: its ability to achieve cost reductions by centralizing certain functions (e.g. seismic analysis, 3-D imaging), while enabling the more extensive distribution of others (e.g. production).

Globalization and Geographies of Knowledge in the Oil Industry

Despite their potential analytical and commercial significance, emergent geographies of knowledge in mature industrial sectors like the oil industry have not been examined closely. Anecdotal evidence suggests that the relative significance of different knowledge types is changing within the industry. On the one hand rapid technological change in exploration is creating valuable sets of technology-specific skills that are portable and largely independent of local conditions. This holds the potential to devalorize locally specific geological knowledge while simultaneously enabling the extension of global reach by oil firms. On the other, the opening of countries to foreign investment and the proliferation of different physiographic and socio-political regulatory environments within a company's portfolio of projects create new knowledge requirements, many of which are highly locality-specific. It would appear, therefore, that the oil industry exhibits at least two contradictory trends in terms of its geographies of knowledge: technological change is increasingly de-territorializing some types of knowledge (i.e. making them less place-specific) while organizational and geographical shifts are simultaneously territorializing other forms of knowledge (Table 25.1). We argue that these trends are significant not only for what they can tell us about restructuring within the oil industry, but also because they provide an opportunity to critically evaluate, through empirical study, a number of broader assertions about the extent and significance of the knowledge economy.

Critically evaluating such claims should be a significant part of any research agenda that is designed to harness work on geographies of knowledge to that on

the practices that constitute and sustain global reach. Our use of the oil industry to illustrate how such research might develop highlights two further challenges. The first is to recognize the complexity of changing geographies of knowledge within mature industrial sectors. While some changes serve to centralize certain types of knowledge and associated practices, others encourage a more distributed or dispersed network of agents and institutions through which knowledge is mobilized. Some of these changes clearly serve to territorialize economic activity, while others have the opposite effect. Moving beyond the traditional conflation of tacit knowledge with the local scale, and distinguishing between knowledge types – as exemplified in Table 25.1 – allows for a more nuanced assessment of the changing geographies associated with developing knowledge economies. The second challenge is to recognize and interrogate the embeddedness of knowledge and knowledge networks within the broader political economies that structure mature industrial sectors. Recognizing the limits of knowledge and knowledge economies – or, at a minimum, the ways in which knowledge networks are shaped by broader political and economic dynamics – provides critical leverage for understanding the dynamics of contemporary economies and, in turn, holds much promise for informing the debate over the prospects for, and limits of, economic globalization.