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The Junggar Basin: The Next Chinese Oil Frontier?

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A Research Paper

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A Research Paper

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The Junggar Basin: The Next Chinese Oil Frontier?

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Summary

Information available as of 14 April 1987 was used in this report.

Northwestern China is a potential major new source of oil for Beijing in the next decade. We estimate that potentially recoverable oil reserves in just the Junggar Basin—one of three oil basins in this region—amount to at least 8 billion barrels. This amount nominally represents:

- Reserves roughly equal to the 10 billion barrels of recoverable reserves in Prudhoe Bay, Alaska.
- Forty percent of present Chinese oil reserves, estimated by most industry reports in the 20-billion-barrel range.
- Reserves adequate to support production of about 1 million barrels per day (b/d) for more than 20 years, an amount that could help China remain an oil exporter well into the next century.

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Because of the intentionally conservative estimating approach we have taken, there is a good chance that our estimate is on the low side. Indeed, on the basis of what we know about subsurface geological conditions in this basin, the size of the petroleum-bearing structures that are likely to be present, and the experience of producers operating in geologically analogous areas, there is a reasonable chance that potentially recoverable reserves in the Junggar Basin could be double the amount we currently project.

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China must realize commercial production in the northwest at the levels we envision from Junggar to remain a net oil exporter and to maintain strong domestic economic growth in the 1990s. China's major oilfield at Daqing—which now provides more than 40 percent of China's oil—is at peak production and faces a decline, possibly within the next few years and certainly by the mid-1990s. Meanwhile, China's hope of supplementing onshore production with offshore discoveries has dimmed as exploration has failed to locate significant finds.

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Full-scale development of the Junggar Basin presents a formidable task, however. Located in China's remote northwest, Junggar is more than 1,600 kilometers from potential consumers and from the domestic resources needed to develop this basin. Xinjiang Autonomous Region, where Junggar is located, is linked to the rest of China by only a handful of poor roads and a single rail line. Development of the necessary infrastructure, determination of the proper scope of foreign participation, and selection of a comprehensive development plan for a 1-million-b/d operation will take much time. Rocky terrain and drifting sands within the basin will complicate the exploration, drilling, and transport of oil.

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We doubt that China can develop this area on its own quickly enough to offset a decline at Daqing. Infrastructure requirements are considerable, and, given normal Chinese bureaucratic inertia and infighting, simply garnering political support and funding for the project will take time. Moreover, the Chinese lack the technology to thoroughly explore the Junggar Basin, or to effectively exploit the oil in its deeper reservoirs.

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For now, Beijing appears resistant to coproduction agreements in the northwest and, because of budget and foreign exchange constraints, is keeping imports of equipment and expertise to a minimum. We expect, however, that as the decline in production at Daqing becomes a more immediate concern, Beijing will seek foreign assistance in the northwest. The timing of this decision and the interest of foreign firms—which will depend on Chinese inducements and world oil prices—will determine whether China can bring Junggar on line before Daqing declines.

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Indeed, the Junggar Basin could present Western firms with their largest investment and trade opportunities in China to date. Exploration and development of the Junggar Basin could easily cost more than $1 billion, and pipeline construction could entail outlays of $6 billion. We expect Beijing, however, to be a tough negotiator and to maximize Chinese content of any cooperation or equipment contracts it signs. Although many Western countries can supply China with the technology it needs, the United States is generally regarded as the world's leader, and some evidence suggests that the Chinese prefer US technology.

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The oil prospects in northwestern China could also prove a factor in Sino-Soviet relations. Development of Junggar, close to the Soviet border, could encourage the Soviets to compete actively with the West for development contracts in northwestern China. Although Beijing views Soviet technology as inferior, its availability through countertrade or ruble credits could prove attractive. Although we see little Soviet interest in oil purchases from this region, large-scale imports of Chinese natural gas are possible.

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Contents

25X1

Figure 1
Selected Oil Basins and Oilfields

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The Junggar Basin: The Next Chinese Oil Frontier?

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Introduction

Northwestern China is generally recognized as one of the few remaining undeveloped regions in the world with great oil potential. Three major oil basins exist in this area—Junggar, Tarim, and Qaidam. Given the size of the areas involved and what we know of the geologic conditions likely to be present, the oil potential of northwestern China could be huge. We estimate that recoverable reserves in the Junggar Basin—the region where Chinese oil developments are furthest along and our technical information base is best—are enough to have major implications for China's long-term energy picture, offer substantial potential business opportunities for the United States, and add a new factor to Sino-Soviet relations.

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Background

China is the world's fifth-largest oil producer. Production increased rapidly from about 900,000 barrels per day (b/d) in the early 1970s to more than 2.6 million b/d in 1986. Practically all of the growth resulted from the expansion of China's three largest oilfields located at Daqing, Shengli, and Huabei (figure 1). These fields currently account for about 90 percent of China's oil production. Oil exports increased, with the growth in production, from negligible amounts in the early 1970s to some 570,000 b/d of crude oil and about 120,000 b/d of refined products in 1986. Oil exports now account for about 20 percent of China's annual hard currency earnings. In terms of a domestic energy source, oil accounts for only 20 percent of China's energy needs, meeting demand primarily in the transportation and petrochemicals sectors. With 770 billion tons of coal reserves, China's reliance on coal for 75 percent of its domestic energy needs—primarily electric power generation and household and industrial heating—will continue into the next century.

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China rarely reveals estimates of its oil reserves, and any estimates Beijing gives to foreigners or mentions in the press must be used with caution. Generally, Chinese estimates refer to oil-in-place, rather than recoverable reserves. Nevertheless, most studies by specialists familiar with the Chinese oil situation place the country's proved oil reserves in the 15- to 25-billion-barrel range. At 15 billion barrels, China's reserves approximate those of Nigeria; at 25 billion barrels, they are akin to those of Venezuela. Most of China's oil reserves are concentrated in a few areas, with about 90 percent of proved oil reserves located at Daqing, Shengli, and Huabei.

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China's domestic oil consumption has been growing at about 4.5 percent annually during the last 10 years—much slower than its 9.5-percent average economic growth—as Beijing has increased its export revenues from oil while holding down domestic demand. We believe production needs to grow to at least 3.5 million b/d by 1995 to meet our minimum projection for domestic requirements in that year and keep exports steady at 1986 levels. Barring development of the Junggar Basin, such an outcome is highly unlikely. China's main oilfield at Daqing currently produces about 1 million b/d—almost 40 percent of Chinese production—but the field is now almost 30 years old and the best the Chinese can hope for is to keep production steady until the mid-1990s. Even this outcome depends on a massive influx of Western technology, most of which is financed by low-cost loans from the World Bank.

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Although it is impossible to predict accurately how rapid the decline at Daqing will be, when it does occur it will have a major impact on China's total oil production.

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25X1 Development of China's potentially rich offshore oil resources has been disappointing. China's continental shelf had been widely touted as an area of vast 25X1 hydrocarbon potential—possibly one of the world's largest offshore sources of oil. Although these claims may ultimately prove close to the mark, 25X1 China's offshore reserves amount to only about 700 million barrels, at most 3 to 25X1 5 percent of the country's estimated total.

25X1 **The Junggar Basin in Perspective**

The Junggar Basin in northwestern China can become a major new source of oil for China in the 1990s and beyond. Huge reserves of natural gas are also likely to be present, opening up the possibility that gas will figure more heavily in China's energy picture, either by meeting domestic needs or through exports to nearby Soviet markets. Technical analysis of the Junggar Basin indicates that:

- Potential oil reserves could amount to at least 8 billion barrels, a resource about equal to that in 25X1 Prudhoe Bay, Alaska (10 billion barrels).
- Gas reserves could approach 9 trillion cubic feet.

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If these potential reserves are confirmed by exploration drilling—a process likely to take at least five years—Junggar could increase present Chinese oil reserves by about 40 percent and more than triple the country's estimated gas reserves. Because of the intentionally conservative approach we have taken, our present estimate of the oil and gas potential of the Junggar Basin is more likely to be low than high. Indeed, on the basis of what we know about the size of the petroleum-bearing structures likely to be present and the favorable subsurface geological conditions, there is a reasonable chance that the amount of oil and gas recoverable could be double our present 25X1 estimate. [1]

[1] See the appendix for the methodology used to estimate the oil and gas reserves.

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Some Basic Geographic Factors

The Junggar Basin is a triangular-shaped depression located in Xinjiang Autonomous Region in northwestern China. The area is sandwiched 25X1 between Mongolia to the east and the Kazakh Republic of USSR to the west. The basin is roughly the size of Illinois and is located in the most remote and least densely populated area of China, factors that will make investment in infrastructure a costly proposition. For example, the nearest hookup point to a major Chinese oil pipeline is at Zhengzhou, roughly 3,000 kilometers southeast of the basin. Few rail lines now exist, and surface roads are primitive at best. A small oil pipeline exists connecting the Karamay oilfield—Junggar's only oil-producing field—with a small refinery at Urumqi, the only large city near Junggar. 25X1

The geography of the Junggar Basin is favorable for oil and gas development because of its generally level terrain and favorable desert climate. Indeed, the Junggar Basin is highly analogous to the state of Wyoming where year-round oil and gas operations are difficult, but certainly not impossible. The northern half of the basin is a stony desert and is essentially undeveloped, although several narrow roads connect small villages near the northern periphery. Additional infrastructure development in the north will be limited by the rocky landscape. The southern half of the basin is a sandy desert and contains dunes that average 5 to 12 meters high. Construction of additional roads and pipelines in this area will be hindered by poor foundation sand properties and by frequent windstorms that cause sand to block transportation routes. Although nearly enclosed by mountains, four natural passes provide potential, albeit difficult, oil and gas transportation routes out of the Junggar Basin. 25X1

Excellent Prospects for Large Reserves

All of the necessary geological conditions to generate oil exist in the Junggar Basin. Source rocks needed to generate the oil are present in large thicknesses, porous and permeable reservoir rocks are well

positioned to catch the oil generated in the source rocks, and impervious seals are sufficiently thick to trap the oil in reservoirs. Initially, the key measure of a region's oil potential is the amount of oil-in-place. Oil-in-place is the total estimated amount of oil that may have migrated into a reservoir, most of which, for economic or technical reasons, will never be extracted. On the basis of our analysis of the geological conditions that are likely to exist in the Junggar Basin, we estimate oil-in-place at about 40 billion barrels.

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Determining the amount of oil-in-place that is economically recoverable requires delineation (measurement) drilling at a scale far beyond anything that has occurred in the Junggar Basin to date. On the basis of oil production experiences worldwide, the Chinese can reasonably expect to recover from 20 to 40 percent of the oil-in-place. Much depends on the reservoir characteristics and the efficiency of production operations. Assuming that the Chinese recover only 20 percent, potentially recoverable reserves would amount to about 8 billion barrels. This recovery rate, however, is lower than recovery rates achieved by many producers in similar regions.

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Our analysis indicates that the Junggar Basin consists of 10 geological provinces (figure 3). Source rocks known to be present, ranging in geological age from the Jurassic to the Carboniferous Periods, are organically rich and very productive. We estimate that about 1.8 billion barrels of potentially recoverable oil lies in the southern flank of the Junggar Basin in an area referred to geologically as the Urumqi Foredeep. Another 3.6 billion barrels are probably about equally divided between three provinces that straddle the northern part of the basin referred to as the Karamay-Wuerhe Step, the Wulungu Depression, and the Sangequan Arch. [2] The remaining provinces throughout the Junggar Basin all are likely to contain less than 1 billion barrels each of recoverable reserves, according to our analysis (table 1). Many of the basin's central areas have been "overcooked" and whatever oil that may have been generated has long since been burned off. In general, our analysis indicates that smaller fields are likely to exist along the periphery of the basin. Average field sizes will probably get larger toward the center of the basin.

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Some Production Possibilities

Oil development in the Junggar Basin, thus far, has been small scale. Surface prospecting began in 1951, and oil production began at the Karamay field in 1955. Karamay is now China's fifth-largest oilfield but, reflecting the extreme concentration of China's oil production, contributes less than 3 percent to current national production. According to

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Embassy reporting, China will invest about $275 million in the Karamay field—including a $100 million loan from the World Bank—in hopes of raising production to 140,000 b/d by 1990. The projected increase in production is clearly reasonable in view of the large amounts of oil that are likely to exist.

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On the basis of our engineering assessments, we believe that the reserve base in the Junggar Basin as a whole is sufficient to support production of about 1 million b/d for more than 20 years, a common planning period used in the West. How soon these levels are reached will depend, in our view, on when the Chinese begin development, their willingness to open the basin to Western oil companies, the pace of infrastructure improvements, and the eventual scope of the investments made in this region. We believe that if Western firms participate from the start, production in Junggar could conceivably reach a few hundred thousand b/d by the mid-1990s and increase to about 1 million b/d by the late 1990s.

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At this stage—before any firm Chinese decision to proceed on a significant scale in the northwest—forecasting production levels for the Junggar Basin is highly speculative. We do not know what priority the Chinese will give to the development of the basin, or even if they will focus on it first and leave large-scale development of Tarim and Qaidam until sometime after the turn of the century. The Tarim Basin is geographically 10 times as large as Junggar, suggesting that potential reserves could well be measured in tens of billions of barrels, although we have not completed a detailed analysis of its prospects. The Qaidam Basin is the smallest of the three, but it is also closest to existing Chinese oil distribution lines and therefore may be the least costly to develop.

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[2] The Chinese already have an oilfield in operation in Karamay-Wuerhe Province that produces about 75,000 b/d.

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Figure 3
Geologic Provinces of Junggar Basin

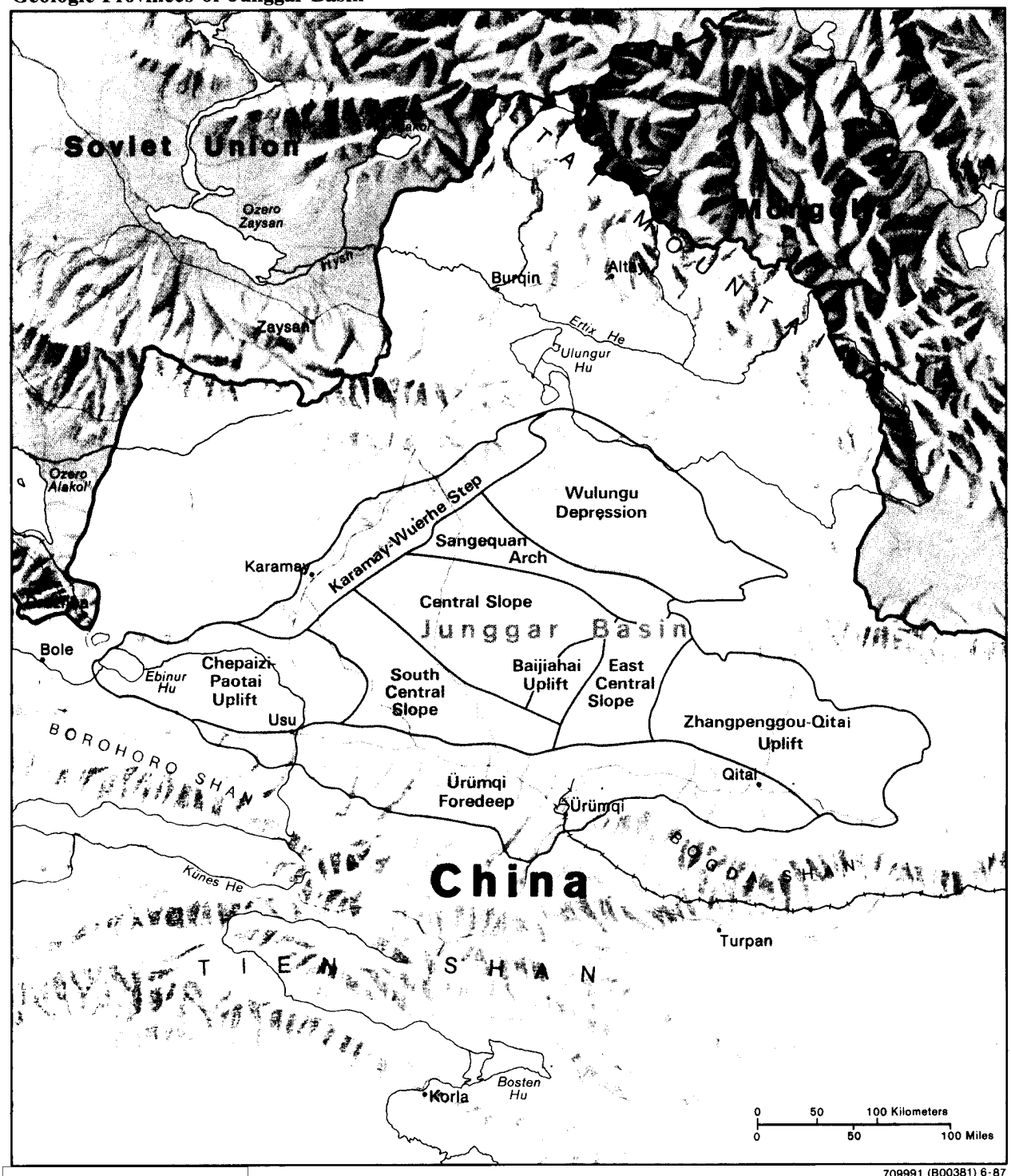

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Table 1
Junggar Basin: Estimated Hydrocarbon Resources

Geologic Province	Potentially Recoverable Oil Reserves *(billion barrels)*	Gas Reserves *(trillion cubic feet)*
Total [a]	**8.3**	**8.9**
Urumqi Foredeep	1.8	2.6
Karamay-Wuerhe Step	1.3	0.6
Wulungu Depression	1.2	0
Sangequan Arch	1.2	1.5
Central Slope	0.8	0.8
South Central Slope	0.8	0
East Central Slope	0.7	0
Baijiahai Uplift	0.2	2.3
Chepaizi-Paotai Uplift	0.2	1.1
Zhangpenggou-Qitai Uplift	0.1	0

[a] Because of rounding, components may not add to the totals shown.

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It is possible that, because of the potentially massive amounts of oil involved, the Chinese will ultimately decide to concentrate their efforts on the development of the Tarim Basin. However, exploration in Tarim is far less advanced and given its enormous size—the basin is about the size of the state of Texas—there is virtually no chance that significant production could come out of the basin until after the turn of the century. With foreign help, China stands a chance of getting Junggar into at least partial production by the mid-1990s, a time when new oil supplies will be badly needed. Without foreign assistance, we believe that Junggar will not figure in the Chinese oil picture until after the turn of the century at the earliest.

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We think that China's domestic need for oil will continue to grow at about the same pace registered during the last 10 years, largely in response to growing needs in the industrial and transportation sectors. If these trends continue, China's domestic oil consumption could grow to about 3 million b/d by the mid-1990s, as compared with some 2 million b/d in 1985.

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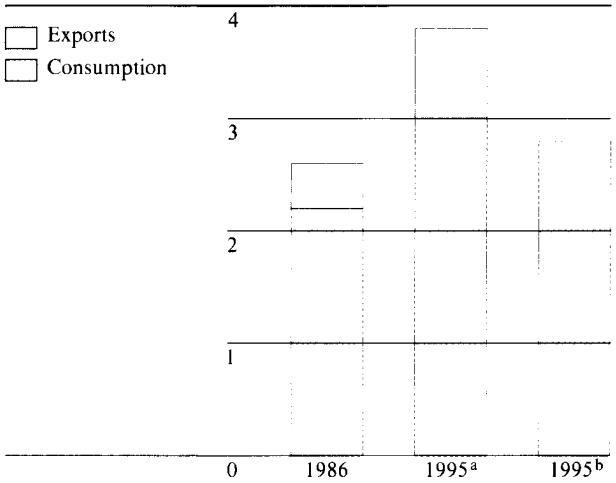
Figure 4
China's Oil Balance, 1986-95



[a] With development of Junggar.
[b] Without development of Junggar.

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Production from current fields will inevitably decline. China's major field at Daqing, which provides 40 percent of China's oil, is at peak production. In our view

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the best Beijing can hope for is to hold production stable at Daqing between now and the mid-1990s. Even that outcome is not guaranteed because it assumes that the Chinese will continue to make substantial purchases of Western secondary and tertiary recovery equipment.

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On balance, if development of the Junggar Basin proceeds and production begins to grow along the lines we think are possible, China's oil production could increase to about 3.8 billion b/d by 1995, an amount that should be more than adequate to meet domestic needs in that year and at least maintain exports at 1986 levels. Barring development of the Junggar Basin, however, we believe that China's exportable oil surplus will become increasingly squeezed and could conceivably be eliminated by the mid-1990s (figure 4).

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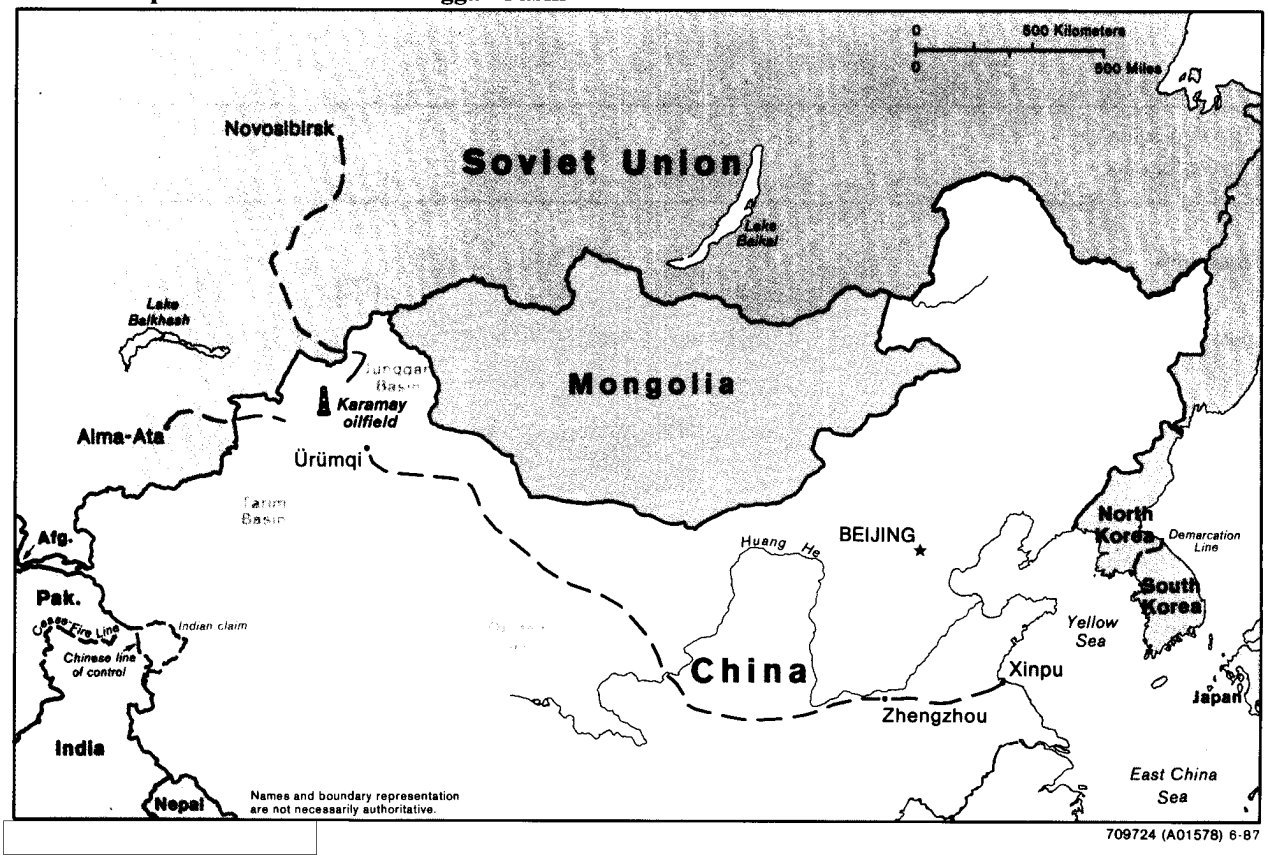
Figure 5
Possible Pipeline Routes From Junggar Basin



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Investment Requirements

Development of the resource potential of the Junggar Basin will require an enormous investment. The key variable that will determine the size of the overall investment will be the pipeline route chosen to move the oil from fields to Chinese or other markets. Natural pipeline routes, following passes in the mountains, could run west or north into the Soviet Union or east to hook up with existing Chinese distribution lines. Oil and gas in the Junggar Basin are likely to occur in separate areas, giving the Chinese the choice of developing either oil or gas, or both (figure 5).

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There are major implications in choosing one pipeline route over another. The cheapest alternative would be to construct a gas pipeline from the Junggar Basin to Alma-Ata in the Kazakh Republic of the USSR, a distance of about 600 kilometers. To be worthwhile, a 42-inch line carrying at least 2 billion cubic feet per day would be needed. According to our engineering analysis, the cost of constructing such a line would be about $1.3 billion. A similar line running north to Novosibirsk would cost about $2.6 billion. Constructing an oil pipeline to the east would be even more expensive. an oil pipeline from the Junggar Basin would need to carry at least 1 million b/d to be economically worthwhile. The Chinese would probably need to build a 36-inch line to carry this amount of oil. Running such a line to the nearest hookup point at Zhengzhou would cost almost $5 billion. The cost would rise to almost $6 billion if the line were extended to an export terminal at Xinpu on the Yellow Sea coast (figure 6).

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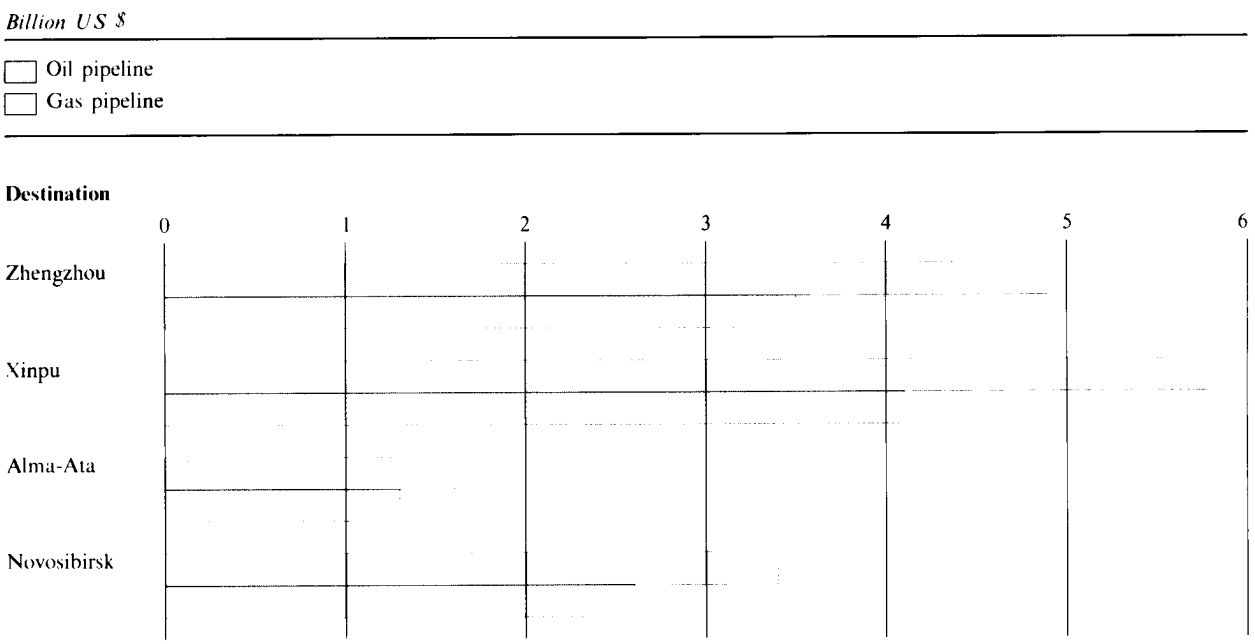
Figure 6
Estimated Pipeline Construction Costs



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Regardless of the type of pipeline built or the preferred route, we believe that, at a minimum, Beijing will need to spend about $1 billion on infrastructure—roads, powerlines, gathering stations, and gathering lines—within the Junggar Basin before oil and gas production could begin. Some infrastructure already exists in the Karamay oilfield area, and refining capacity exists at Urumqi; however, production levels that can be expected from full development of the Karamay field will overwhelm existing facilities. In addition, our analysis indicates that there is significant oil and gas potential outside of the Karamay oilfield area now being developed with World Bank assistance. These other areas are located around the periphery of the basin. Although some infrastructure is already in place, many improvements and expansions are needed before petroleum production can begin in new areas of the Junggar Basin.

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Technology Requirements

China will need Western technical assistance in oil and gas exploration, as well as oil and gas field development, if it is to stand any chance of having Junggar even partially on line before Daqing goes into decline. Beijing admits that it has only a superficial knowledge of the natural resource potential of northwestern China and has already made overtures to various Western firms to assist in exploration of the region.

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Essential to rapid and effective development of Junggar is the means to collect basic, but high-quality, geological data on the area. Exploration carried out thus far has been too limited to complete a comprehensive assessment of the region in a reasonable

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length of time. Cooperation with foreign petroleum service and equipment companies outside of the immediate vicinity of the Karamay field has been minimal. Meanwhile, domestic efforts at exploration have been hampered by poor cooperation between the Ministries of Geology and Petroleum, whose officials occasionally have refused to cooperate or share exploration data with each other. Moreover, domestic exploration equipment is largely out of date, and the Chinese have not demonstrated an ability to use modern imported exploration equipment effectively.

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Chinese drilling technology is also not advanced enough to properly evaluate the oil potential of the Junggar Basin.

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Chinese oil exploration rigs in the Junggar Basin can drill only to 3,000 meters. Our study indicates that a significant part of the undeveloped oil and gas reserves in the Junggar Basin could occur below 4,000 meters. The Chinese will have to import Western drilling rigs or rely on Western oil companies to develop these reserves.

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Beijing has the technical ability to construct pipelines from the Junggar Basin to eastern China or into the USSR. The Chinese enjoy a well-deserved reputation for successfully constructing engineering projects in some of the world's most inhospitable locations. Construction of a pipeline along any of the routes that we think are possible would not present the Chinese with insurmountable technical problems. It would, however, be enormously expensive for China to do on its own.

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Implications

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Development of the petroleum potential of the Junggar Basin presents the United States with potentially enormous trade possibilities. Depending on China's determination of the proper role of foreign involvement, equipment and service contracts let to foreigners for Junggar could amount to billions of dollars, but Beijing will clearly try to maximize the domestic content of any contracts. US firms have previously enjoyed substantial success in competing for sales to China, selling $248 million in oilfield equipment to China in the 1970s and another $500 million through 1985. In view of the success of the trade ventures thus far, we believe that the United States has established a firm competitive position in the Chinese market.

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Moreover, we believe China's key needs in developing Junggar include technology and know-how, areas in which the United States is particularly strong. Exploration technologies, such as remote sensing, seismic interpretation, and computer-assisted geochemical and geophysical analysis, are critically needed and are all areas in which the United States is a recognized world leader. Given the size of the area involved, an investment of at least several hundred million dollars could be required to explore the area thoroughly; however, the Chinese would probably require that foreign partners use Chinese equipment, materials, and labor wherever possible.

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US engineering firms—recognized world leaders in long-distance pipeline construction—have an excellent opportunity to participate in the construction of oil and gas pipelines to eastern China. An oil export pipeline to Xinpu on the Yellow Sea, for example, could involve as much as $6 billion in foreign contracts and domestic Chinese outlays. A gas pipeline along the same route would probably cost $4.1 billion.

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. . . For the Soviet Union

The Junggar Basin's proximity to the Soviet border is likely to pique Moscow's interest in China's plans for oil and gas there. We believe that the Soviets might try to compete with the West for some of the business that development of the Junggar Basin would create. Although Soviet technology lags behind the West, it could be well suited for China's needs. A possible deal with the Soviet Union could also enjoy some support among the Chinese leadership. For example, Vice Premier Li Peng, who oversees China's energy policy, supports close economic ties to the USSR. 25X1

Other economic factors come into play that involve both sides of the Chinese and Soviet border. A pipeline from Junggar into the Soviet Union could be built at a fraction of the cost that would be entailed in the construction of one to eastern China. The Soviets have vast experience in pipeline construction and could build oil or gas lines without much difficulty. Although the Soviets seem to be meeting Central Asia's oil demands from domestic sources, gas supplies from China could play an important role in meeting future Soviet domestic requirements. Gas production in Soviet Central Asia cannot keep pace with demand; indeed, the Soviets already need to transport gas from Western Siberia to meet some of Central Asia's needs. Importing gas from China could be a far less costly arrangement. 25X1

The Chinese are unlikely, however, to depend heavily on the USSR as a major export market, and the Soviets may not trust Beijing as a supplier. Furthermore, given the tendency between the two to engage in countertrade, success in negotiating a deal may depend on whether Soviet sales of pipeline technology, equipment, and construction services can be paid for with future Chinese natural gas deliveries. 25X1

Appendix

Technical Methodology

The oil and gas potential of the Junggar Basin was estimated using petroleum source rock geochemistry. This methodology estimates recoverable oil and gas reserves by calculating the amount of oil and gas generated from organic matter in source rocks, determining the proportion of generated oil and gas effectively trapped in reservoir rocks, and determining how much trapped oil and gas is actually recoverable. Using this methodology, we estimate that there is an excellent chance that the Junggar Basin contains at least 8.3 billion barrels of potentially recoverable oil (table 2) and 8.9 trillion cubic feet of potentially recoverable gas (table 3).

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The amount of oil and gas that is generated in a given area is calculated by estimating the amount of organic material in the area that experienced the proper burial times and temperatures for oil and gas generation. Source rocks are organic-rich black marine shales or limestones that will generate oil when subjected to sufficiently high temperatures for a long period of time. Whether oil or gas is generated depends on the length of time a source rock is subjected to a given temperature. Source rocks subjected to relatively low temperatures for a short period of time will not produce oil from organic matter; source rocks subjected to much higher temperatures for too long will have their oil and gas dissipated through decomposition. A middle range of times and temperatures exists, however, where oil and gas are generated and preserved (figure 7).

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There is limited reliable information on the organic content of source rocks in the Junggar Basin. As a result, we estimated the amount of organic matter in Junggar Basin source rocks using analogy to geologically similiar basins. Because the geologic history of the area is well known and conservative organic content figures were used, we believe the actual organic content of Junggar Basin source rocks is not likely to be below the amount we estimated.

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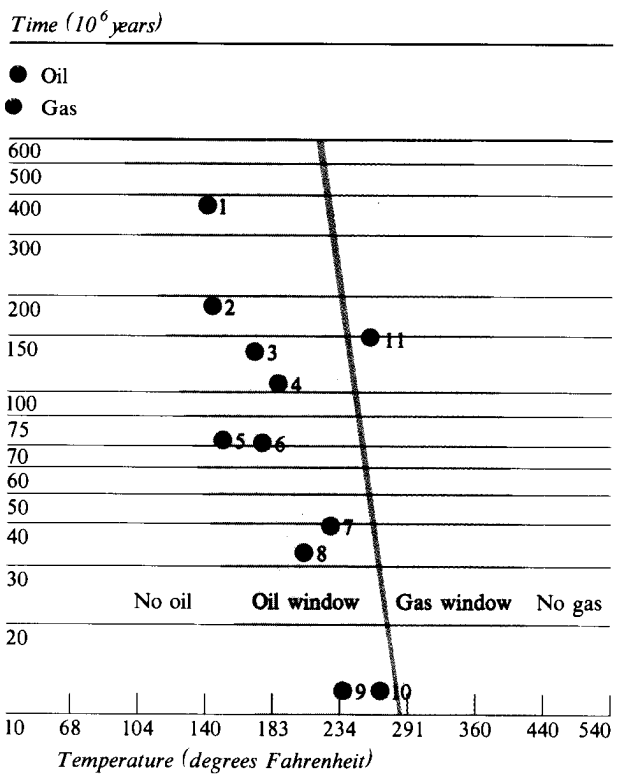
Figure 7
Location of Oil and Gas Windows According to Time and Temperature Framework



1 Amazon Basin, Brazil
2 Paris Basin, France
3 Aquitaine Basin, France
4 El Aaiun Area, Rio de Oro, West Africa
5 Douala Basin, Cameroon
6 Offshore Taranaki Basin, New Zealand
7 Camargue Basin, France
8 Offshore Taranaki Basin, New Zealand
9 Los Angeles Basin, California
10 Ventura Basin, California
11 Aquitaine Basin, France

312344 4-87

Since a large proportion of generated oil or gas is not trapped in reservoir rocks but escapes into the atmosphere, a trapping or accumulation factor is applied to the total figures for generated oil and gas. This factor is determined by taking into account the geologic history of the area and the likelihood that reservoir rocks are present to hold the generated oil and gas. The geologic history of the Junggar Basin is well known, and oil exploration to date has shown that reservoir rocks are present. Therefore, we have good confidence in the value of the trapping factor used in this part of the calculation.

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Because current oil extraction techniques recover only a small percentage of trapped oil and gas, a recovery factor is applied to the trapped oil and gas figures to obtain potentially recoverable reserves. This factor depends on conditions in the reservoir rock that contains the oil and gas and on the production methods used to produce oil and gas from the reservoir. For this study, we assumed the recovery factor would be similar to that in geologically similar fields operated by Western companies. Because oil exploration has already defined reservoir conditions in the Junggar Basin, we have high confidence that the recovery rates possible in Junggar will be at least as high as the recovery factor used in this calculation.

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Table 2
Junggar Basin: Estimated Oil Resources

Geologic Province	Volume of Source Rock (KM^3)	×	Weighted TOC [a] Average	×	Carbon Conversion Factor [b]	×	Unit Conversion Factor	=	Volume of Generated Oil	±	Volume of Migrated Oil	×	Accumulation Coefficient	×	Recovery Factor	=	Potentially Recoverable Oil Reserves *(billion barrels)*
Total																	**8.34**
Urumqi	33,704		0.0169		0.023		19.24		252.058		0		0.0364		0.20		1.84
Karamay-Wuerhe	13,863		0.0088		0.025		19.24		58.679	+	31.250		0.0704		0.20		1.27
Wulungu	22,269		0.0163		0.026		19.24		181.579	−	66.023		0.0518		0.20		1.20
Sangequan	5,169		0.0091		0.025		19.24		22.625	+	181.434		0.0286		0.20		1.17
Central Slope	23,036		0.0216		0.023		19.24		220.188	−	105.560		0.0370		0.20		0.85
South Central Slope	16,956		0.0169		0.023		19.24		126.807	−	13.514		0.0370		0.20		0.84
East Central Slope	12,779		0.0263		0.023		19.24		148.726	−	56.957		0.0370		0.20		0.68
Baijiahai	1,101		0.0287		0.023		19.24		13.983	+	29.370		0.0286		0.20		0.25
Chepaizi-Paotai	8,598		0.0075		0.023		19.24		28.536		0		0.0370		0.20		0.21
Zhangpenggou-Qitai	663		0.0122		0.026		19.24		4.046		0		0.0370		0.20		0.03

[a] TOC is the total organic content expressed as a percent of the volume of source rock.
[b] Factor converts source rock volume to weight using average rock density = 2.68 grams per cubic centimeter (gms/cc) oil weight to volume using 30 American Petroleum Institute (API) gravity.

25X1

Table 3
Junggar Basin: Estimated Gas Resources

Geologic Province	Volume of Source Rock (KM^3)	×	Weighted TOC [a] Average	×	Carbon Conversion Factor	×	Unit Conversion Factor [b]	=	Volume of Generated Gas	±	Volume of Migrated Gas [c]	×	Accumulation Coefficient	×	Recovery Factor	=	Potentially Recoverable Gas Reserves *(trillion cubic feet)*
Total																	**8.94**
Urumqi	1,670		0.9471		0.020		3.72		117.675		0		0.0364		0.60		2.57
Baijiahai	2,338		0.4381		0.026		3.72		99.068	+	35.628		0.0286		0.60		2.31
Sangequan	253		0.2380		0.026		3.72		5.824	+	81.089		0.0286		0.60		1.49
Chepaizi-Paotai	2,451		0.2223		0.026		3.72		52.699		0		0.0370		0.60		1.17
Central Slope	5,060		0.3129		0.026		3.72		153.134	−	116.383		0.0370		0.60		0.82
Karamay-Wuerhe	0		0		0.026		3.72		0	+	13.731		0.0704		0.60		0.58

[a] TOC is the total organic content expressed as a percent of the volume of source rock.
[b] This factor converts source rock volume to weight using average rock density = 2.68 gms/cc and gas weight to volume.
[c] Net increase of all migrated gas is a result of migration of all generated gas from provinces with no resultant recovery potential for gas.

25X1