PROCEEDINGS, INDONESIAN PETROLEUM ASSOCIATION
Thirty-Sixth Annual Convention and Exhibition, May 2012

ACCELERATION IN REGIONAL EXPLORATION OF INDONESIA: REQUIREMENT FOR SURVIVAL

Awang Harun Satyana*
Cipi Armandita*
Johnson Achmad Paju*

ABSTRACT

Exploration for oil in Indonesia started in 1850 when systematic mapping of oils seeps was carried out by the Dutch East Indies Government. This, with geological investigation, resulted in discoveries of the first Indonesia's oilfields during 1870s to 1890s in West Java, North Sumatra, South Sumatra, East Java, East Kalimantan and Seram Island.

During the 20th century, it showed that Indonesia was significant oil and gas producer regionally, with peak oil production reached two times, around 1.68 million BOPD in 1977 and 1995. Interestingly, these two peaks of production were preceded by two peaks of accelerated massive exploration almost ten years earlier, respectively. However, since 1990, exploration has been diminishing; this will endanger the survival of Indonesia as significant oil and gas producer in the future. It is obvious that exploration is a requirement for production survival.

Sedimentary basins of Indonesia are both productive and prospective, as well as challenging. Indonesia may also be the most diverse country in the world with at least 50 proven and probably more than 100 speculative petroleum systems. Exploring Indonesia is worthy, but Western and Eastern Indonesia, each should be treated particularly.

Recent mapping shows that there are around 2430 structures identified in all working blocks in Indonesia, 1200 structures of which are drillable prospects with P50 121 BBO and 545 TCFG resources in place. If parts of these resources can be realized, they will survive Indonesia as significant oil and gas producer.

Massive and accelerated exploration is required to realize these resources. Both investors and the related institutions in the Government of Indonesia should realize and cooperate to address the issues such as: conflicting regulation, overlapping land use, regional autonomy, forestry, taxation, cabotage policy, data access, financial capability, harvest strategy in producing blocks, and high risk-frontier areas.

Massive exploration will survive Indonesia as petroleum producer.

INTRODUCTION

For almost 130 years, since the beginning of commercial petroleum industry in 1885, oil and gas have played an important role in the development of Indonesia. By the early 1980s, the oil and gas sector in Indonesia accounted for one fourth of the country's gross domestic products, more than two-thirds of government revenues and over four-fifths of the nation's merchandise exports. Indonesia today still remains dependent on the petroleum industry to fuel the nation's development and as a primary energy source for more than its 240 million people. However, having reached peak oil production in 1977 when 615 million barrels oil was produced during the year (1.68 million barrels oil per day) (Figure 1), the production, after some up and down fluctuations until early 1990s, keep declining steadily until 2011's production yield 330 million barrels oil (0.903 million barrels oil per day). Gas production started to be significant in 1977 when Arun giant gas field in North Sumatra was commenced to produce. Gas fields have been increasingly discovered and produced since then (Figure 2). The declining oil production was compensated by increasing gas production. In 2002, gas production in million barrels equivalent exceed oil production. In 2011, total oil and gas production of Indonesia was averagely 2.4 million barrels oil equivalent, with gas contributed 1.5 million barrels oil equivalent. Gas therefore, has been more important than oil in production point of view for the last ten years.

* BPMIGAS

There are many reasons for declining oil production. The decline in production is a consequence of the fall in output from many of the old fields and the exhaustion of some, 80% of Indonesia's fields are mature fields. A characteristic feature of the petroleum geology of Indonesia is that, unlike the Middle East fields, most of the fields are small, they are relatively fast to be exhaustive to produce oil therefore new fields have to be discovered and brought into production to sustain output (Ooi, 1982). The generally small size of the oil fields is a result of the fact that the Tertiary basin architecture in Indonesia does not provide the trapping mechanisms for major oil fields (Klemme, 1975). Except for a few fields in the Central Sumatra Basin (notably Minas and Duri fields) and the Kutei Basin (Handil field), the average size of oil fields is less than 20 million barrels of recoverable oil.

The fall in production had its roots not only in the rapid decline rates of the characteristically small reservoirs of Indonesia, but also in the low level of exploration. Massive exploration is required for the survival of Indonesia as oil producer, both in producing blocks to increase new reserve replacement ratio and in exploration blocks to find large fields to become good oil producers in the future. Petroleum geology of Indonesia with its proven and potential petroleum systems will account for a massive exploration. However, there are many challenges to realize massive exploration.

METHODS

This paper will present some trends on exploration and production issues of Indonesia and strategic solutions related to the issues. This is based on various data collected and analyzed for long periods to get the trends. Publications related to the theme are also studied and compared with the analyses. All data are reviewed, analyzed, interpreted and synthesized to present integrated explanation. Examination of past exploration statistics and patterns can serve as a useful guide for assessing and ranking remaining opportunities in mature areas, and can also provide models for resource assessment and exploration strategy applicable to newly emerging frontier areas (Howes and Tisnawijaya, 1995).

RESULTS

Lessons from History

Oil has been used in Indonesia as daily materials since early centuries. Oil from seepages was used for medicinal purposes. There is historical note that oil from seepages in Aceh region in Sumatra was used as fuel in naval battles along the Sumatra coast as early as the eighth century AD. Indonesia was famous for its mineral wealth including oil, long before its spices attracted the attention of European traders and adventurers and drew them to its shores. However, systematic exploitation of oil did not begin until the second half of the nineteenth century (1850s). In 1850, Corps of Mining Engineering was formed by the Dutch East Indies Government and one of its tasks was to systematically map oil seepage in the whole country.

The Head of the Mines Department, C. de Groot, was confident that petroleum could be produced in commercial quantities in Indonesia. In 1865, the list of oil seepages in Indonesia was completed, enumerated a total of fifty-two oil seepages and their yields. The first attempt at oil exploitation in Indonesia was made by Jan Reerink, a general store owner in Cirebon, West Java who decided to try his luck at the oil venture. In 1871, he began drilling at Cibodas at the NW foot of Mount Ciremai to the south of Cirebon guided by the presences of oil seeps. He found some high quality oil but the yield was too small and because lack of capital, he gave up after five-year attempt. History of petroleum industry in Indonesia began in 1885 when A.J. Zijlker, the Dutch manager of the East Sumatra tobacco company, drilled the second well at oil pool at Telaga Tunggal (in concession named Telaga Said, Langkat area North Sumatra) and found oil in commercial quantities at a depth of only 121 m.

The discovery of oil in commercial quantities at Telaga Said provided a great stimulus to exploration and drilling in other parts of Indonesia conducted by companies specially established to exploit petroleum. Until 1920s, many fields were discovered in East Java, South Sumatra and East Kalimantan. The Royal Dutch/Shell Group through its operating company, the BPM (Bataafsche Petroleum Maatschappij) gained full domination of the Indonesian oil industry. Before the World War II, two Indonesia's biggest oil fields, Minas and Duri fields were discovered in Central Sumatra and until now keep contributing biggest production for Indonesia.

The period 1965-1966 could be regarded as a watershed in the history of the Indonesian oil industry contemporaneous with the change of politics. New era of petroleum industry in Indonesia began with the Government introduced the principle of production-sharing contract (PSC) whereby the government of Indonesia and the contractor (foreign oil companies) shared the oil produced. The year 1966 also witnessed a shift in the focus of interest among the oil companies – from onshore to offshore oil. Thirteen oil companies signed production-sharing agreements between 1966-1968, ushering a new era in the history of the petroleum industry of Indonesia.

By introduction of the PSC system, exploration and production of oil in Indonesia increased very significantly. The 1970s have seen the discovery and production of oil on a scale dwarfing that of all previous decades (Ooi, 1982). One indication is that the number of oil fields discovered in the seven years 1970-1976 was ten times the number discovered in the decade 1960-1969, and more than twice the total number discovered in the eighty years 1890-1969. Production increased steadily from 170 million barrels in 1966 to a high of 615 million barrels in 1977 (1.69 million barrels per day). Year 1977 was peak oil production of Indonesia.

Prospectivity of Indonesia

Geologically, Indonesia occupies one of the most complicated areas on Earth. The archipelago is made up of three major crustal plates and numerous micro-plates of both continental and oceanic origins. This tectonic setting provides Indonesia with numerous sedimentary basins and inter-basin areas where petroleum accumulations are either proven or possible (Figure 3).

Petroleum resources of Indonesia has been explored and produced for more than 140 years. Yet, the Indonesia's oil and gas potential and production are still important regionally. National and multi-national companies are still venturing these resources. The potential of unexplored resources is still large in both Western and Eastern Indonesia. Indonesia may also be the most diverse country in the world with at least 50 proven and probably more than 100 speculative petroleum systems (Figure 4). Controlled largely by the different geological regimes of Western and Eastern Indonesia, the pattern of petroleum accumulations differ across the archipelago. Understanding the geological evolution and how the various sedimentary basins being developed are the keys to understanding the petroleum systems of the sedimentary basins.

Exploration conditions in the western and eastern portions of Indonesia are quite different from an oil industry standpoint (Figure 5). Exploration and production activity has been intense in the western part during the last 140 years. Western Indonesia probably has fewer very large undiscovered fields. The remaining potential is most likely numerous small to medium size hydrocarbon accumulations. Here the primary objectives are dominantly Tertiary age sediments. A very different situation exists in Eastern Indonesia. This region is generally under-explored with half of the basins being undrilled and the other half having highly variable amounts of drilling activity. A number of sedimentary basins in Eastern Indonesia are high-risk frontier areas. Primary hydrocarbon objectives include both Tertiary and Pre-Tertiary sediments that have been proven to be productive in a number of structures. One can speculate that the possibility of truly large accumulations is probably much higher though the associated risks are high as well. A number of large fields have been discovered in the Salawati, Bintuni and Arafura Sea areas. Other fields are in Bula and Banggai Basins, discovery wells are distributed in various areas both onshore and offshore.

Recent mapping shows that there are around 2430 structures identified in all working blocks in Indonesia (Figure 6), 1200 structures of which are drillable prospects with P50 121 BBO and 545 TCFG resources in place. If parts of these resources can be realized, they will survive Indonesia as significant oil and gas producer.

Exploration Vision

It is axiomatic that to remain viable companies would have to explore, to discover oil or gas in sufficient quantities not only to pay for the unsuccessful ventures, but also to provide adequate returns to capital invested.

The following is taken from Wallace E. Pratt's classic article on philosophy of oil finding (Pratt, 1952). One indispensable attribute of the successful oil-finder is vision. Levorsen has said "until a discovery well has been drilled the undiscovered oil or gas field exists at best only as an idea in the mind of the geologist." If it is the mind of geologist, or the oil-finder, that new fields first take form, then discovery must wait on our mental visualization our imagination. Where oil is first found, in the final analysis, is in the minds of men. The undiscovered oil field exists only as an idea in the mind of some oil finder. When no man any longer believes more oil is left to be found, no more oil field will be discovered, but so long as a single oil-finder remains with a mental vision of a new oil field to cherish, along with freedom and incentive to explore, just so long new oil fields may continue to be discovered.

Exploration campaign in petroleum is motivated by two interrelated factors: first a specific geologic condition promising an economic petroleum accumulation; and second, an investor who is willing to risk his money with expectation of a high rate of return (Sujanto and Hartoyo, 1994). The specific geologic conditions, now more fashionably called the petroleum system, by definition is a system that encompasses a pod of active source rock and all its related oil and gas which include all the essential elements and processes needed for oil and gas accumulation to exist. With respect to the level of investigation, the petroleum system falls at the second stage of sequential investigation; namely, sedimentary basin, petroleum system, play, and prospect investigation. Ideally, exploratory drilling can be carried out if a prospect can be generated from its exploration play. This play has to come from an area within an established petroleum system. Nevertheless, in real life, explorationists can always convince the investor that a prospect was generated using petroleum system logic. It is a thought process required to develop an integrated interpretation of the processes of petroleum generation, migration, and accumulation (Sujanto and Hartoyo, 1994). The application of petroleum system logic often allows the explorationist to reduce the evaluation problem to the careful assessment of a single factor.

Massive Exploration Resulted in Peak Production: Records

Petroleum exploration or the search for oil and/or gas fields is a basic requirement to find oil and/or gas field. Past records show simply that the more exploration the more fields discovered, other wisely the less exploration the less fields discovered. No exploration, no field discovered, no production. Therefore, today's exploration is tomorrow's production.

When the government of Indonesia opened the PSC system in 1966/1967, the first fifteen PSCs were signed in 1967-1968, with some more companies concluding more than one contract. The companies are: Union Oil, International Oil Exploration, Phillips Petroleum Company of Indonesia, Total Indonesie, Indotex, Virginia International, IIAPCO, Agip, Continental Oil, Mobil Oil, Indonesia Frontier Petroleum, Javasea Oil and Indonesia Gulf Oil. These companies conducted massive exploration especially in offshore areas of Indonesia. Massive seismic surveys were carried out mostly between 1969-1974 recorded 573,500 km 2D seismic, nearly 90 % of which were conducted under PSC system. New seismic data acquisition techniques and modern high resolution seismic data processing are enabling the interpreter to identify not only the simple structural traps but also more complex targets.

No final proof of the existence (or absence) of hydrocarbons in an area can be obtained except by drilling of wells. The companies also conducted massive exploration drilling. The number of wells drilled increased dramatically from only one in 1966 to 180 wells in 1974. Altogether, 1536 exploration wells were drilled from 1966-1979, of which 73 % was by production-sharing contractors (Ooi, 1982).

Exploration for oil in Indonesia, fuelled by high success ratios, has intensified as the number of oil companies operating in the country increased rapidly in the late 1960s and early 1970s. Massive exploration efforts during this period were rewarded by discoveries of many fields. Total number of fields discovered from 1970-1976 were 140 fields, compared with total 68 fields discovered from 1890-1969 (Ooi, 1982) (Figure 1). Massive exploration will result in massive field discoveries. Massive exploration of early 1970s caused peaked oil production of Indonesia's petroleum industry history was reached in 1977, producing 1.68 million barrels oil per day. It proves that yesterday's exploration is today's production, or today's exploration is tomorrow's production.

Less Exploration Resulted in Low Reserve Replacement Ratio: Records

Exploration in terms of wildcat well drilling has been significantly diminishing since early 1990s (Figure 7). Exploration activities in producing blocks, where new discoveries if any will be sooner put on production to compensate production from existing fields, have been declining for the last 15 years. Realization of exploration investment in producing blocks for the last ten years were only 4 to 7 % from total budget causing replacement ratio of new oil discoveries have been under 10 % to oil produced annually. This eventually, will endanger the survival of Indonesia as oil producer.

Exploring Frontier Areas: High Risk High Reward

The problem with focusing exploration activities in conventional areas was that the discoveries, if by, would be small. Due to the deficit balance of reserves discovery to production (low reserve replacement ratio) since exploration efforts mostly were carried out in mature areas with small volumetric of new fields discovered, the Government has had to change its growth strategy. This negative balance has caused Indonesia to be a net importer in the year 2004 considering the rapid growth of crude demand for domestic use. Large to giant discoveries are requirement to make a positive balance. The choice is frontier exploration. Frontier exploration is seen as the only response to the challenge to find significant additional reserves that could enable Indonesia to replace its high production. Exploration in frontier area is high risk but high reward (Figure 8).

The worsening external business environment in the last decades forced the Government to compete for dwindling frontier exploration funds. This effort was taken very seriously as indicated by the issuance of incentive packages. It was for this reason that, since 1988, the Government has issued incentive packages to ensure financial return to the investors under poor economic conditions. The incentives were aimed at handling frontier risks and issues such as geological complexity, remoteness and deep water. The issuance of incentives four times within only 5 years (in 1988, 1989, 1992 and 1994) indicated that the Government was willing to change its policies as required by the external environment (Sujanto and Hartoyo, 1994). The responses from oil companies were good, there were many companies went to frontier areas in Eastern Indonesia and after struggling with petroleum geology and exploration efforts, significant, large to giant fields, mainly gas were discovered from the late 1980s to 2000 (Tangguh gas fields, Senoro, Donggi, Abadi gas fields).

Frontier exploration in Indonesia continues today. There are three areas to concentrate for frontier exploration: Aru-Arafura Sea, Berau Bay (Semai) and West Sulawesi Offshore. Two wildcat wells targeting Paleozoic reservoirs have been drilled in the Aru-Arafura Sea at Amborip VI (Aru-1, ConocoPhillips, 2011, dry) and Arafura Sea Block (Mutiara Putih-1, ConocoPhillips, 2011, dry with oil show). Three wells have been drilled in Semai areas targeting Mesozoic and Tertiary reservoirs (Lengkuas-1, Semai II, Murphy, 2011, dry; Andalan-1, Semai V, Hess, dry; Andalan-2, Semai V, Hess, dry). Twelve wells have been drilled in West Sulawesi Offshore since 2009 by five operators. The first well in the region, Rangkong-1, well was drilled by Exxon Surumana in 2009. The well failed to find hydrocarbon. Exxon moved to other block in this area, Mandar Block, and drilled three wells of the block's firm wells commitment, called Sultan-1 (2009), Kris-1 (2010), Kris-1 ST (2010). Sultan-1 discovered uneconomic gas possibly biogenic in nature. Kris-1 and Kris-1 ST were dry holes due to tight reservoir and absence of reservoir, respectively. Marathon drilled their first well in Pasangkayu Block, Bravo-1 (2010) and continued with Romeo-1 (2010, mechanical trouble), Romeo-B1 (2010, mechanical trouble), and Romeo-C1. Bravo-1 and Romeo-C1 failed to find hydrocarbon despite good carbonate reservoir objectives were encountered. The turn then came to ConocoPhillips in Kuma Block, they drilled Kaluku-1 well (2011). The well failed to encounter carbonate objective but when it was deepened, the well recovered very waxy oils, solidified at surface temperature, from Eocene reservoirs. Prospectivity of West Sulawesi offshore in South Makassar Basin was ventured by Lempuk-1 well, drilled by Talisman in Sageri Block in late 2011. The well failed to find hydrocarbon from its carbonate objective. The carbonate was encountered with fair to good reservoir properties. The last two wells drilled by Statoil in Karama Blocks, targeting Neogene objectives in thin-skinned structures, the wells were Gatotkaca-1 (2012) and Anoman-1 (2012). Both wells failed to find hydrocarbons. Petroleum system implications post-drill in West Sulawesi Offshore is reviewed by Satyana et al. (2012, this volume).

It is exceptional for the first wildcat well drilled to be successful. Such dry wildcats will, nevertheless, provide information which may eventually prove to be highly important. The fact that a number of wells will usually have to be drilled in an area before a commercial deposit of oil or gas is discovered is a well-known risk in the oil industry.

New Oil in Old Places

Exploration is essential to increase hydrocarbon reserves. Exploration is high risk and may be high cost, and international production is highly taxed in many areas. The time between discovery and first production can be several years, and the average size of fields discovered is decreasing in many basins. These factors can make exploration unattractive. Another important source of increased reserves can be found within or adjacent to existing fields, especially in reservoirs producing by depletion or weak water drive. Apparently recoverable reserves in such fields may be only 12 to 30 % of the original oil in place. In United State basins, except in the deep-water offshore Gulf of Mexico Basin, most reserve additions in the recent past are being produced from improvements to mature fields. Nehring (1995) showed that in the United States from 1983 to 1992, about 85 %, or 20 billion barrels, of proved oil-reserve additions were from old fields. The application of new exploration and production technology, along with appropriate oil field practice, is the driving force behind finding new oil in old places (Sneider and Sneider, 2001)

This is proven in Indonesia, reserve replacement of oil based on 2000-2010 data, mostly (69%) came from new oil recovered from existing fields. New fields contributed only 18% to replace the reserve produced.

Challenges for Accelerated Massive Exploration

Accelerated massive exploration as occurred in the late 1960s and early 1970s, resulting in peak oil production of Indonesia in 1977, is very difficult to repeat today due to the presences of some problems or challenges which have never occurred before. Issues such as: conflicting regulation, overlapping landuse, regional autonomy, forestry, taxation, cabotage policy, data access, financial capability, harvest strategy in producing blocks, and high risk-frontier areas can make accelerated massive exploration difficult to realize.

Some problems and challenges are detailed as follows.

1. Expensive exploration with drilling cost around US$ 70 million and can be around US $ 200 million if there are complicated problems such as occurred to one well drilled in 2011. High exploration cost causes the operators to give up soon once their considered-best wildcat well fail to find hydrocarbon. Actually, it is exceptional for the first wildcat well drilled to be successful. Such dry wildcats will, nevertheless, provide information which may eventually prove to be highly important. The fact that a number of wells will usually have to be drilled in an area before a commercial deposit of oil or gas is discovered is a well-known risk in the oil industry.

2. Overlapping land uses and difficult permission, especially problem in onshore area. Classic example is along the Central Range of Papua. Its counterpart in Papua New Guinea has been explored intensively for more than twenty years and resulted in reserves around 3.1 billion barrels oil and on production. Petroleum working areas in Central Range of Papua has never been explored since middle 1990s due to overlapping issue with National Park of Lorentz which came later.

3. "Unreal" petroleum operators, meaning that the companies hold the working blocks for the sake of portfolio or for re-selling to other operators, not for exploring petroleum. This is indicated by rapid increase of total working blocks in Indonesia for the last ten years but it has not been paralleled by rapid increase in exploration or there are many proposals for commitment deferment.

4. Land indemnities and various regional regulations, onshore cases, have made difficult acceleration of massive exploration onshore. Acquiring land areas for seismic surveys or wells take much time and costly.

5. Limited seismic parties, seismic vessels and onshore-offshore drilling rigs, making acceleration of massive exploration will be difficult. Sharing rig used by many operators in one region is one of solutions to simplify procurement process and rig availability.

6. No availability of previous data, actually registered to exist, will postpone evaluation and therefore will postpone exploratory operations.

7. Subsurface complexity is a classic challenge in frontier area due to scarcity of references and controls, but it can be more understood as exploration activities conducted and data are available.

CONCLUSIONS

Indonesia has long history of petroleum exploration and production, one of the oldest countries in the world with petroleum industry. Indonesia found PSC system in 1967 and attracted many multinational companies ventured under this system, conducted massive and accelerated exploration, not long after its introduction. Accelerated massive exploration during late 1960s and early 1970s resulted in peak oil production of Indonesia reached in 1977 when Indonesia produced 615 million barrels oil or 1.68 million barrels oil per day. However, exploration has been in serious decline for almost fifteen years due to many reasons involving many parties, companies, government and related institutions. The effect is obvious, new field discoveries have been minimal, not until 10% replacing annual production from existing fields. Accelerated massive exploration is required for survival of Indonesia as significant oil producer. It is difficult to realize this due to many challenges never occurred before, but close cooperation among involved parties would be helpful for exploration efforts. Today's exploration is tomorrow's production.

REFERENCES CITED

Howes, J.V.C. and Tisnawijaya, S., 1995, Indonesian petroleum systems, reserve additions and exploration efficiency, Proceedings Indonesian Petroleum Association, Twenty Fourth Annual Convention, 1-17.

Klemme, H.D., 1975, Giant oilfields related to their geological setting: a possible guide to exploration, Bulletin Canadian Petroleum Geologists, V. 23, 1, 30-66.

Nehring, R., 1995, The impending crisis in U.S. oil production: what can be done about it: 1995 SPE Hydrocarbon Economics and Evaluation Symposium, SPE Paper 30059.

Ooi J.B., 1982, The Petroleum Resources of Indonesia, Oxford University Press, Kuala Lumpur.

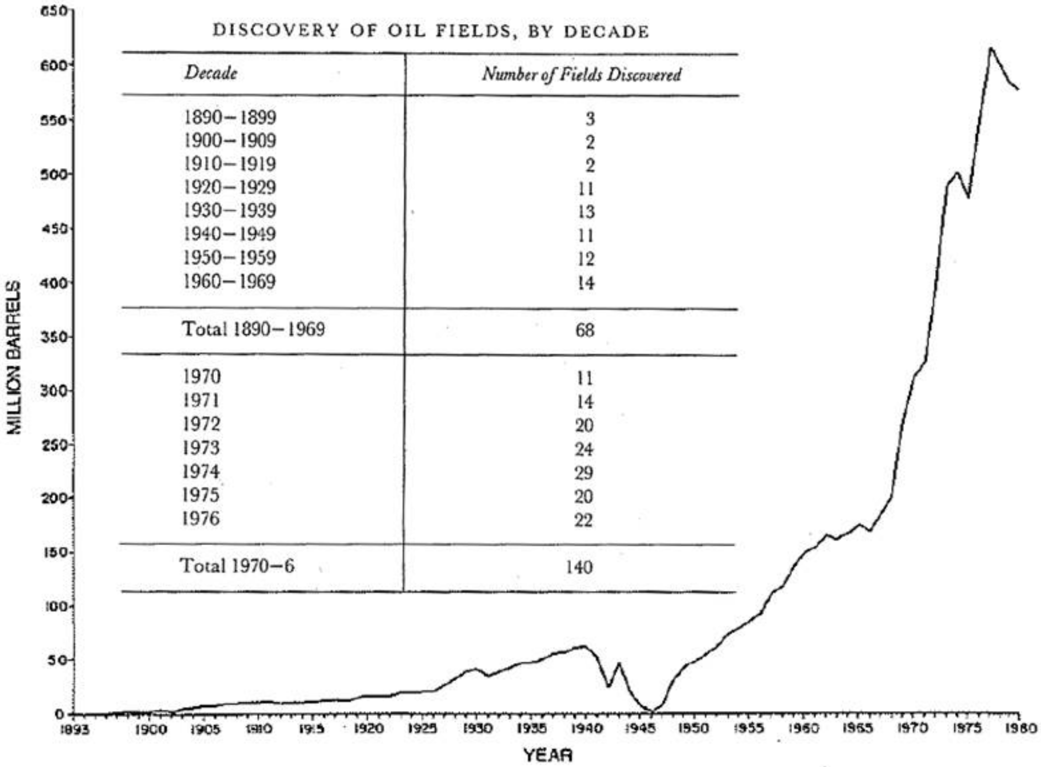
Satyana, A.H., Damayanti, S., Armandita, C., 2012, Tectonics, stratigraphy and geochemistry of the Makassar Straits: recent updates of exploring West Sulawesi offshore, opportunities and risks, Proceedings Indonesian Petroleum Association, Thirty Sixth Annual Convention, this volume.

Sneider, R.M. and Sneider, J.S., 2001, New oil in old places: the value of mature-field redevelopment, in Downey, M.W., Threet, J.C. and Morgan, W.A., eds, Petroleum Provinces of the Twenty-First Century, AAPG Memoir 74, 63-84.

Sujanto, F.X. and Hartoyo, P., 1994, Indonesia variety of business arrangements and incentives for petroleum upstream activities: a strategic management perspective, Proceedings Indonesian Petroleum Association, Twenty Third Annual Convention, 21-33.

Sujanto, F.X., 1997, Substantial contribution of petroleum systems to increase exploration success in Indonesia, Proceedings of the Petroleum Systems of SE Asia and Australasia Conference, 1-14.

Sumantri, Y.R. and Sjahbuddin E., 1994, Exploration success in the eastern part of Indonesia and its challenges in the future, Proceedings Indonesian Petroleum Association, Twenty Third Annual Convention, 1-20.



Decade	Number of Fields Discovered
1890–1899	3
1900–1909	2
1910–1919	2
1920–1929	11
1930–1939	13
1940–1949	11
1950–1959	12
1960–1969	14
Total 1890–1969	68
1970	11
1971	14
1972	20
1973	24
1974	29
1975	20
1976	22
Total 1970–6	140

Figure 1 - Historical records of massive and accelerated exploration during early 1970s resulted in discoveries of 140 fields in seven years only, compared to 68 fields discovered during 79 years from 1890-1969. This massive and accelerated exploration caused Indonesia reach its peak oil production in 1977, producing 615 million barrels that year (Ooi, 1982).

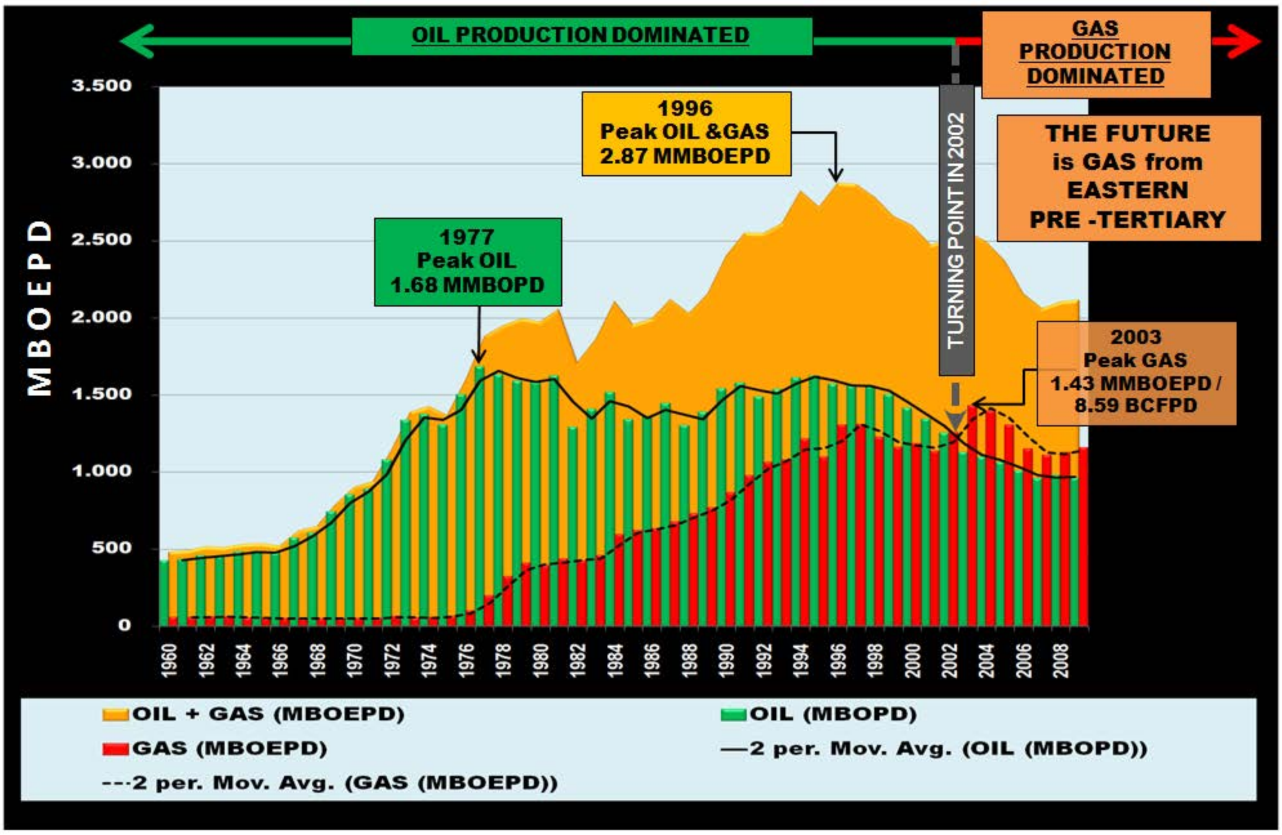


Figure 2 - Gas compensated declining oil production. In 2002, gas production in million barrels equivalent exceed oil production. In 2011, total oil and gas production of Indonesia was averagely 2.4 million barrels oil equivalent, with gas contributed 1.5 million barrels oil equivalent. Gas therefore, has been more important than oil in production point of view for the last ten years.

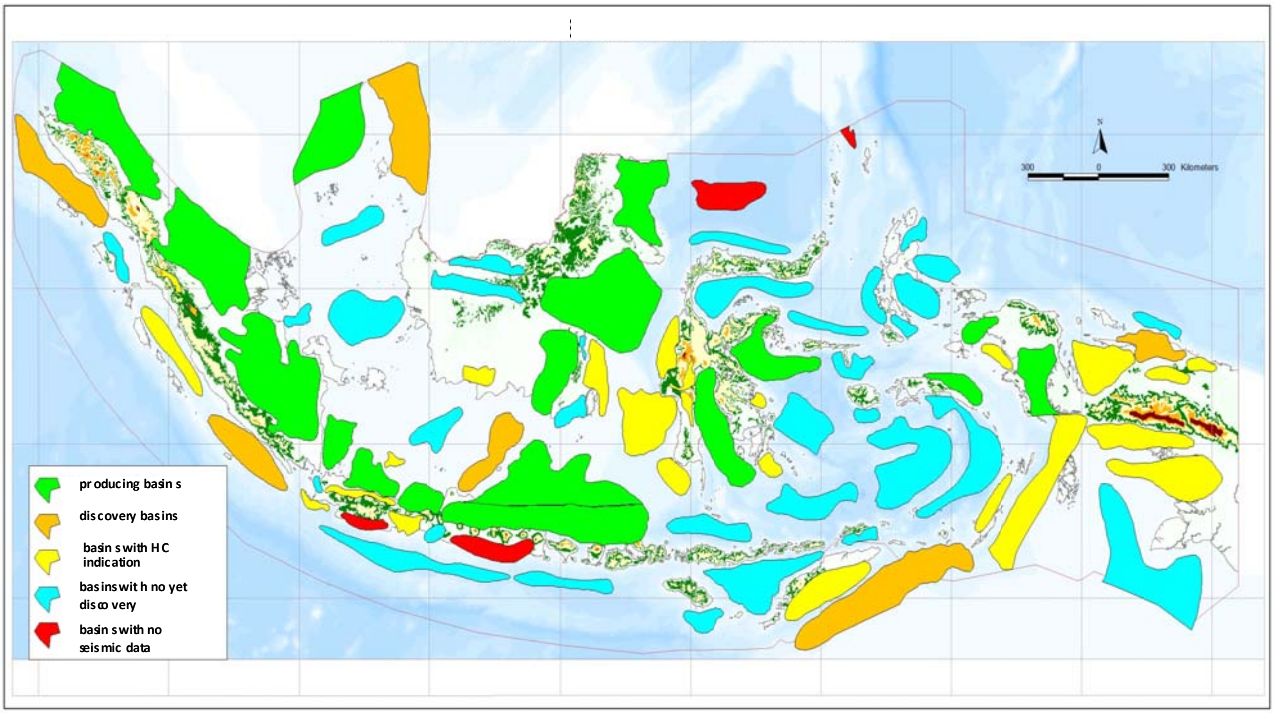
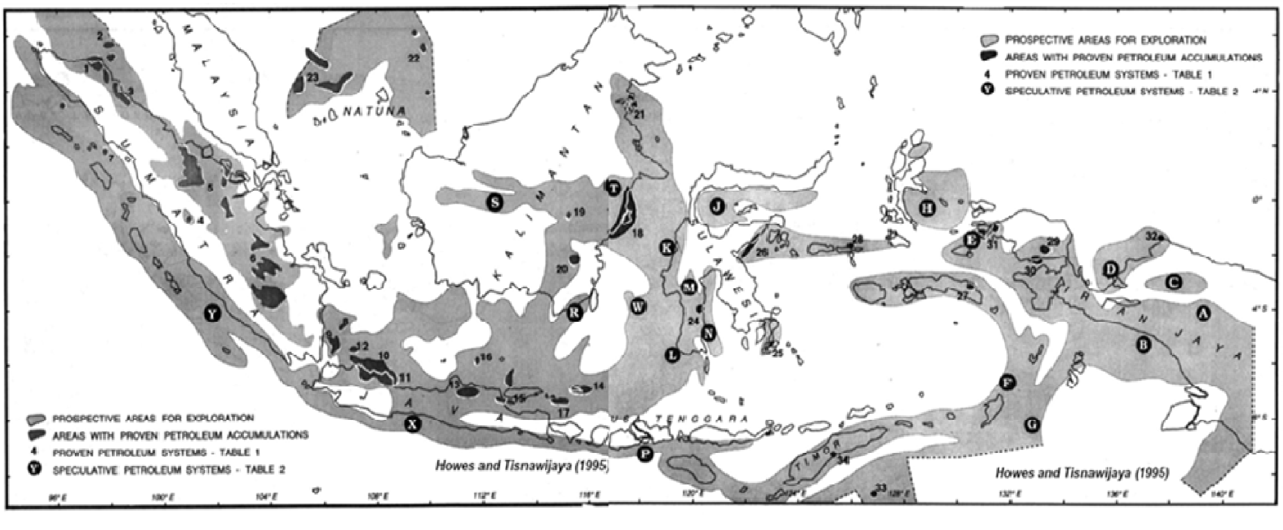


Figure 3 - New mapping of sedimentary basins in Indonesia resulted in 86 basins identified. There are 16 basins producing, 7 basins drilled with discoveries, 25 basins drilled with hydrocarbon indications. There are still 37 basins with no yet discoveries, mostly undrilled and 4 of which with no seismic data.



Number denotes oil & gas fields, letter denotes prospective petroleum systems

Figure 4 - Indonesia owns large proven and prospective areas for petroleum from lowland to mountainous areas, from shallow to deep marine areas. Petroleum systems simply can be grouped into two subdivisions: Western Indonesia petroleum system and Eastern Indonesia petroleum system. Discoveries in one basin can boost exploration efforts in other basins with similar petroleum system. This principle of analogue basins simplify exploration efforts in Indonesia (Howes and Tisnawijaya, 1995).

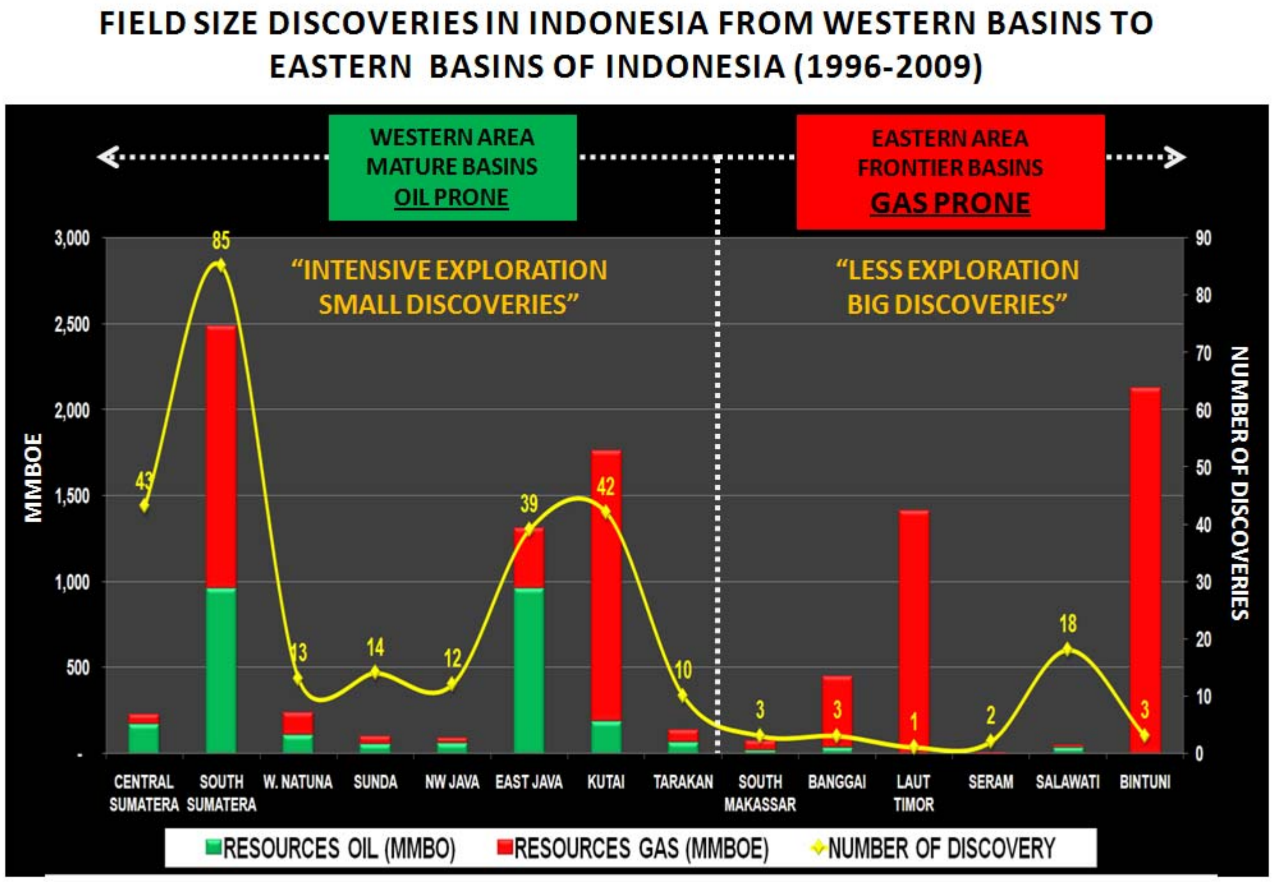


Figure 5 - Comparison of volumetric discoveries in mature area (Western Indonesia) and frontier area (Eastern Indonesia). Intensive exploration in mature area resulted in discoveries of small fields, compared with less exploration in frontier area resulted in several field discoveries with large to giant volumetric.

OIL & GAS RESOURCES IN PLACE OF ALL PROSPECTS IN INDONESIA

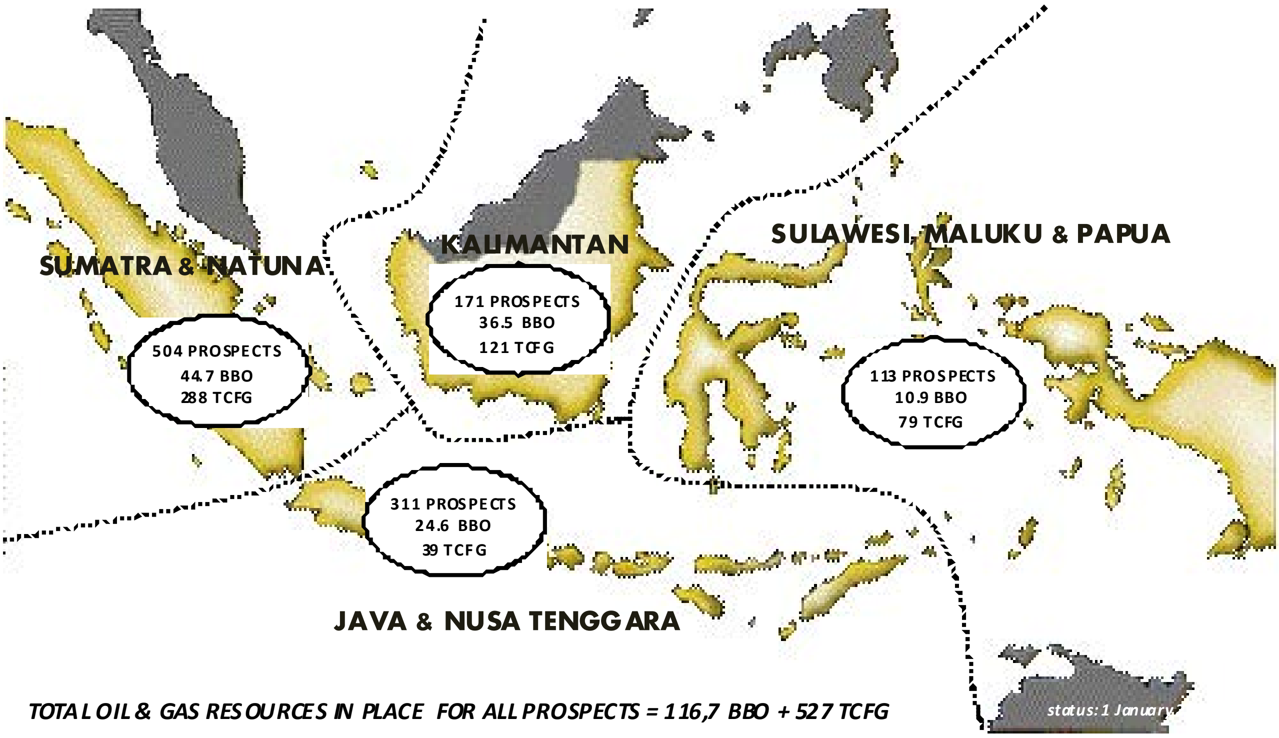
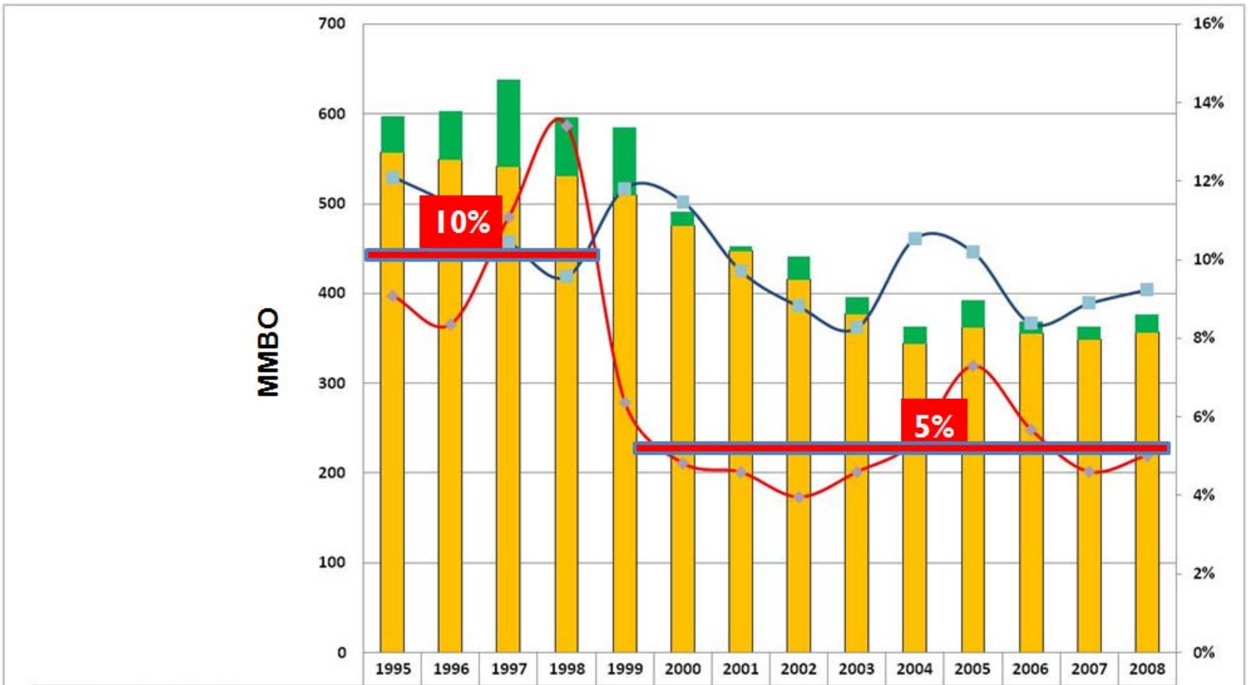


Figure 6 - Sustainability of Indonesia as oil and gas producer will depend on identified prospects. The figure shows good prospectivity of oil and gas resources for the future venture based on prospects identified in existing working areas. These should be proved and realized through massive and accelerated exploration.



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Oil Discovery MMBO	41	55	98	66	76	15	6	26	19	20	31	14	15	21
Oil Production MMBO	557	549	541	531	510	476	447	416	377	344	363	355	348	357
Exploration vs Total expenditures	9%	8%	11%	13%	6%	5%	5%	4%	5%	5%	7%	6%	5%	5%
Administration vs Total Expenditures	12%	11%	10%	10%	12%	11%	10%	9%	8%	11%	10%	8%	9%	9%

Figure 7 - Exploration has been in serious decline for the last ten years. Volumetric of annual new field discoveries account for not until 10 % to volumetric of oil produced from existing fields, meaning very low reserve replacement ratio. Exploration expenditure in these producing blocks have been minimal, currently around 5 % to total budget, even it has been lower than administration expenditure. How exploration can replace oil produced in this situation?

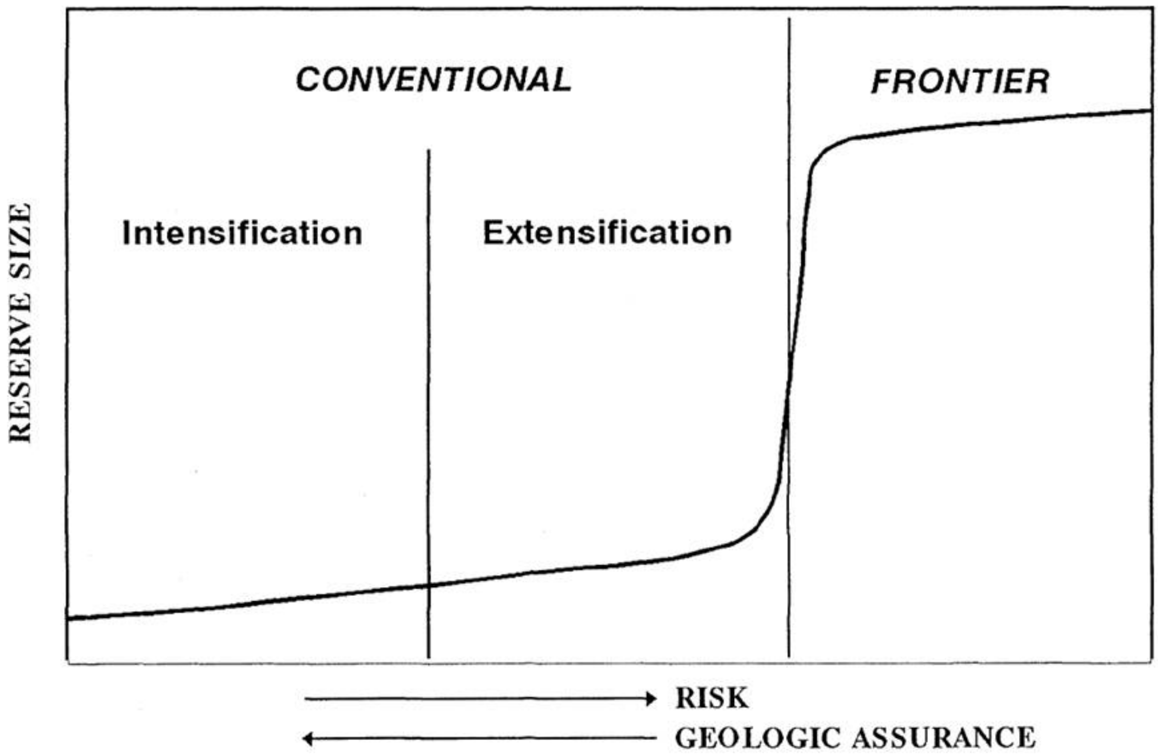


Figure 8 - Indonesia risk and expexted reserve size in exploration activities. Records show that exploration in frontier area is high risk, but several large to giant fields have been discovered in the frontier areas. Frontier exploration needs strong technical, managerial and financial supports resulting in high reward (Sujanto and Hartoyo, 1994).