

INA's Experience in Hydrocarbon Exploration in Croatia

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REVIEW

INA d.d. has carried out systematic hydrocarbon exploration in Croatia since 1952. In the last 62 years it resulted in the discovery of 57 onshore oil and gas fields and 17 offshore gas fields, i.e. 1.4 billion boe of hydrocarbon reserves of which 1.2 billion boe was recovered. The Pannonian Basin can be considered a relatively well explored area where remaining potential should be looked for in unconventional reservoirs and in more complex smaller conventional reservoirs. The Dinarides are still underexplored and considering a number of open professional issues and the demanding terrain, this area is evaluated as being highly risky for further investments; therefore exploration risk sharing with potential partners is how we look at the future exploration activity in this area. In North Adriatic good results were achieved in the exploration of gas reservoirs. Production of gas from this area dates to 1999 and today accounts for a substantial percentage of total domestic gas production, approximately 50%. Exploration of the Central and South Adriatic was less successful compared with the Northern part and the 1st phase of the search for oil ended in the late eighties of the 20th century. Exploration of these areas gained a new momentum with the new seismic acquired by INA in 2011/2012. These data enabled a breakthrough in the traditional understanding of main characteristics of the petroleum system and INA was ready for the 1st offshore licensing round announced by the Croatian Ministry of Economy in April 2014. Considering that from the end of the nineties of the 20th century until the end of the first decade of the 21st century the company's exploration strategy was focused on exploration and production from the North Adriatic, Syria and several African countries, in this period exploration of remaining domestic areas was rather modest. This trend changed in 2009 when INA commenced a new exploration cycle in Croatia intensifying activities in the Pannonian Basin which resulted in several smaller oil and gas discoveries. Selec, Hrastilnica and Đeletovci Zapad are the most successful among them. There is also a current issue of unconventional exploration applying the North American experience. A pilot project of unconventional exploration was undertaken at the end of 2013 continuing into 2014 and beyond. Today one of the main strategic directions of the company is organic growth, i.e. exploration led growth. In this respect, consolidation of domestic exploration portfolio has a significant role. In the new circumstances when Croatian hydrocarbon market is opening and legislation in the field of exploration and production has recently undergone changes we see an opportunity to independently or in partnership with other interested oil companies demonstrate commitment to exploration of these areas and get a chance to pursue new visions, using modern, safe and clean technologies.

Key words: hydrocarbon exploration, conventional reservoirs, unconventional reservoirs, exploration risk, consolidation of exploration portfolio

1. INTRODUCTION

Within INA, a vertically integrated company which operates in exploration, production, refining and retail, exploration has always had a prominent role. Although hydrocarbon exploration activities date to the end of the 19th century, it was only upon the founding of the Naftaplin Company in 1952 that this activity began developing fully and systematically.

Croatian geologists, geophysicists, geochemists, petroleum and chemical engineers and other experts involved in exploration have made a good job over the last 62 years, resulting in the discovery of 58 onshore oil and gas fields and 17 gas fields in the North Adriatic, i.e. in cumulative production of 1.173 billion boe. In the same period, in the area of the Republic of Croatia around 1.4 billion boe of hydrocarbons were discovered.

Croatia has represented a pillar of INA's production and development since the founding of the company; however, as early as the sixties of the last century a need arose to expand to other markets in order to ensure the company's growth through the strengthening of interna-

tional exploration portfolio. We have operated in around 20 countries which helped us gather valuable experience as operators both onshore (in Jordan, North Korea, Egypt, Syria, Namibia, Iran, Russia, and Libya) and offshore (Gabon, Libya, Tunis and Bangladesh). As partners we have been present in more than ten countries such as Vietnam, Turkey, Angola, Burma, Algeria, etc. Internationally, we had successful and less successful moments, eventually managing to bring Angolan, Egyptian and Syrian projects into production. Syria has been in every respect INA's major international success representing a culmination of INA's efforts aimed at finding new hydrocarbon reserves. Considering such positive experience where INA, having 100% share in the project and relying solely on its own resources carried out exploration and brought a complex project into production, we must hope that future INA's international projects will follow suite in terms of profitability.

In this context, it is important to mention that exploration experience gathered in Croatia has enabled creation of a critical mass of know-how within a company which is



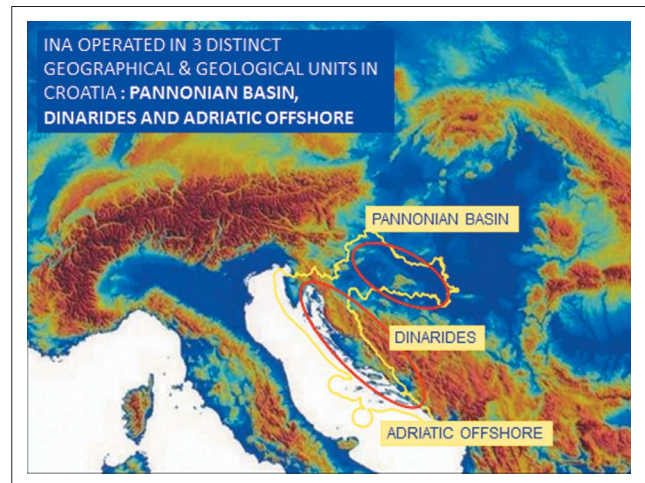
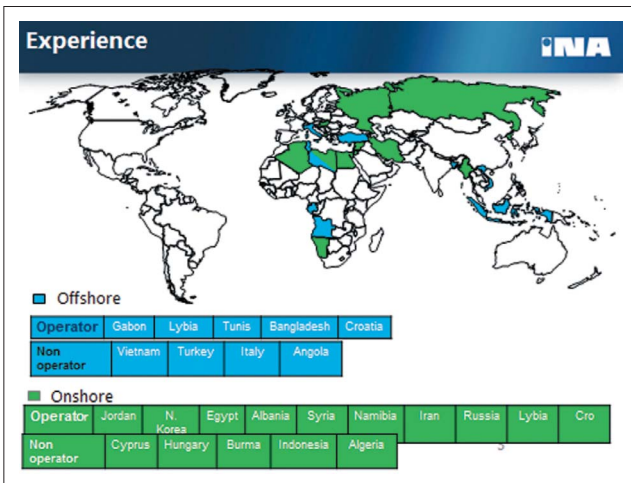
Oil and gas exploration and production activities in Croatia began in the 1870's

INA has been involved in exploration activities in Croatia since 1952

A total of 68 oil&gas fields have been discovered in North Croatia Pannonian Basin

14 gas fields discovered in North Adriatic shallow offshore

CROATIA, RESERVES DISCOVERED TO DATE: 1.4 BILLION BOE



necessary for stepping out internationally, but at the same time international experience has been of invaluable importance for improvements in exploration processes, for gaining experience and use of new exploration ideas domestically.

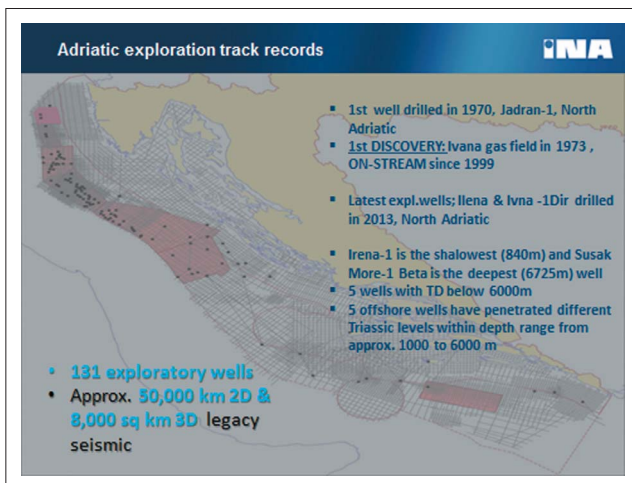
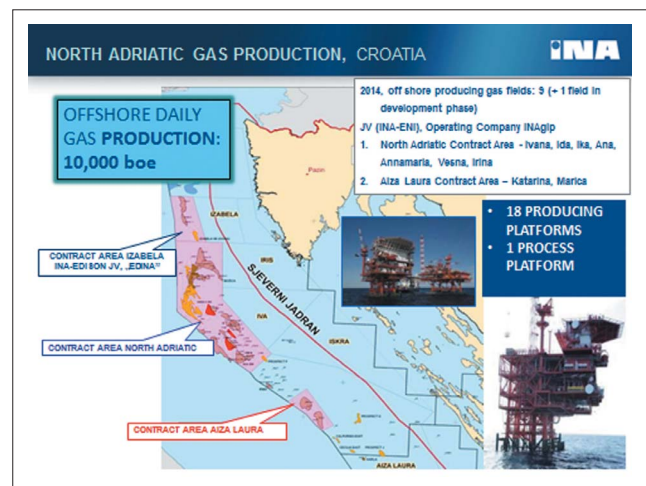
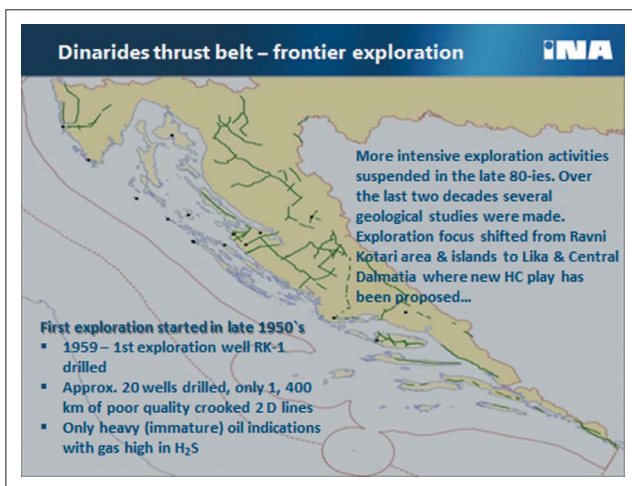
2. Exploration of the Pannonian Basin

According to the international classification the Pannonian Basin in Northern Croatia is a highly explored area with 950 exploration wells or fascinating 2 million meters drilled. To this number we should add around 3 thousand development and production wells. More than 30,000 km of 2D seismic and around 2,800 km² of 3D seismic have been acquired in the Pannonian Basin. First oil fields were discovered in Posavina and most of them are still producing: Križ-Šumećani, Mramor Brdo, Bunjani, Kloštar and Dugo Selo. The then Naftaplina was making constant efforts to raise the scientific- technological level according to international standards which resulted in new discoveries which followed one another in which the introduction of seismic survey techniques played the crucial role. Oil discoveries which were made in the late fifties and the sixties of the 20th century were concentrated in Posavina and Podravina; Stružec and Žutica being the greatest in size and importance. Continuous development of seismic acquisition and processing

technologies resulted in addition of a set of oil and gas fields to Naftaplina production portfolio where we have to point out stepping into a new oil province in Slavonia which was established by Obod and Bizovac field discoveries in 1967, and in particular by the discovery of our largest oil field, Beničanci in 1969.

The seventies and the early eighties saw technological advancements in exploratory drilling which led to breaking the drilling depth record of 4,000 m and discoveries of the largest gas and condensate fields in Podravina. Molve were discovered in 1974, Stari Gradac in 1980, Kalinovac in 1982 and gas production from these fields, in addition to offshore gas production, still represents the backbone of gas production in Croatia. The era of great discoveries of onshore oil and gas fields was rounded up. Until the nineties throughout Northern Croatia small oil and gas discoveries were made until a significant decrease in activities during the Homeland War. One of rare areas in which operations were possible during the war years was Međimurje where in 1993 and 1994 two gas fields were discovered: Vučkovec and Vukanovec.

During the war and in the post-war period the rate of activity of past years was hard or almost impossible to achieve and a new momentum happened in 1994 by the introduction of 3D seismic. Until the end of the nineties



extensive 3D surveys were carried out in North-western Croatia, Posavina, Podravina and Slavonia. As a result of a number of circumstances, until 2010 onshore 3D seismic projects were not capitalised to a sufficient extent i.e. based on such surveys only around 10 exploration/development wells were drilled but did not give any significant results.

The end of the nineties of the last century was marked by a strategic turn of INA in exploration and production. This was the beginning of the era in which INA turned to the implementation of North Adriatic gas projects and international exploration in Syria, Russia, Egypt, Albania and the focus was no longer on the Pannonian exploration. The large investment cycle which primarily included North Adriatic and Syrian projects lasted until the end of the first decade of this century and INA has more seriously dealt with new Pannonian projects since 2009.

3. Dinarides

Parallel with systematic exploration of the Croatian part of the Pannonian Basin, as early as the late fifties and the early sixties exploration of the Dinarides was undertaken. After completed geological prospections, gravimetric, magnetometric and rare seismic surveys of this extremely complex terrain the first exploratory

Dinaride well was drilled on the outskirts of Zadar in 1959. Exploration of the Dinarides was not limited only to Croatia but was expanded to the area of Bosnia and Herzegovina. In the whole of Dinarides a total of 21 wells were drilled with non-commercial oil and gas shows noted in only a few wells. At the end of the eighties an extensive exploration of the Dinarides was carried out within the scope of a mega project financed by the World Bank in which respectable international experts were involved, along with INA oil and gas professionals. This exploration resulted in a study which was supposed to make a basis for further exploratory activities and capital investments. Parallel with the completion of the said study, the Amoco Company, USA showed great interest for these areas and jointly with Naftapljin evaluated the potential of Lika and Dalmatia. Amoco's interest in the continuation of exploration resulted in the signing of a Letter of Intent; however, this cooperation project was never implemented due to the onset of war in these areas. Over the last two decades activities aimed at the Dinarides exploration were reduced to study work and several field prospections which resulted in certain advancements in understanding the genesis and key elements of the petroleum system. Considering all results of exploration carried out until then the area was evaluated as highly risky for further investments and INA's efforts were for a long time focused on the search for partners for exploration risk sharing. At the end of 2012 INA's rights to explore the Dinaride exploration areas expired, meaning that only upon the opening of a licensing round for the exploration of the Dinarides it will be possible to express any interest in the continuation of exploration in these areas.

4. Adriatic

First 2D offshore Adriatic seismic surveys date back to the late sixties and in 1970 the first exploration well, Jadran-1 was drilled. The largest North Adriatic field, Ivana was discovered in 1973. At that time exploration was focused on oil from Mesozoic sediments and gas discoveries were marginalised. Search for oil and lack of adequate technological solutions for gas production and transportation, postponed its production until 1999 when INA entered into a contractual relationship with the

Italian Agip Company. Today 9 North Adriatic fields are producing (Ivana, Ida, Ana, Annamaria, Vesna, Irina, Marica, Katarina), IKA Southwest is in the development phase and production from Izabela is expected in the nearest future.

As already during early exploration of Adriatic the existence of several genetically different geological units were identified, offshore exploration focus shifted from the North Adriatic gas basin to the potentially oil prolific the Dugi Otok and South Adriatic province which implied deep sea drilling requiring adequate drilling rigs. The first jack up platform Pannon was built in 1977 and in 1981 Zagreb-1, a semi-submersible platform was purchased, and very soon in 1985 the construction of the third platform, Labin commenced. New exploration cycle covering the Central and South Adriatic entailed carrying out technologically and financially demanding projects in which implementation INA was partnered by respectable world players: Agip, Chevron, Texaco and Repsol.

Although Central and South Adriatic can be classified as poorly explored, geologically highly risky areas, we should bear in mind that the whole Adriatic is covered with 50 000 km of 2D seismic and around 8 000 km² of 3D seismic along with 97 wells in the north and 33 in the central and southern parts. A total of 240 000 subsea meters was drilled in Adriatic which contributed to our understanding of the elements of the petroleum system.

After thousands of kilometres of seismic acquired and wells drilled; several wells deeper than 6 000 m, it became clear that applied exploration concepts did not yield expected results apart from scarce oil and gas shows. However, pieces of information about the existence of fragmentary components of a petroleum system were collected, at that time enviable drilling records were attained, the state-of-art technological solutions were applied, drilling operations were carried out in the complex environment and we can conclude that through such demanding projects the company became stronger technologically and organisationally. The last seismic surveys of this exploration cycle in the South Adriatic were carried out in 1998 which was the end of the first phase of the "search for oil". A certain degree of disappointment with the results of exploration of this part of the Adriatic, along with the lack of fresh ideas and new concepts, and relatively modest results of exploration in the neighbouring countries with the access to the Adriatic Sea led to the halt of exploration activities until 2011/2012 when INA acquired new 2D and 3D seismic. New seismic which interpretation has been carried out dedicatedly until now has enabled a new insight into the traditional area and INA was ready when the first offshore licensing round was opened in April 2014 by the Croatian Ministry of Economy.

5. Commencement of a new exploration cycle in Croatia

2009 represents a turning point regarding changes in the approach to exploration, redefining of priorities and setting new strategic guidelines. Through analysis of historical results and data, and taking into consideration specifics of each exploration area separately - the Pannonian Basin, the Dinarides, the North, Central and

South Adriatic, new exploration priorities were defined. At that time INA held licenses for 12 onshore and offshore exploration areas of the total area of 108 120 km². Based on the comprehensive inventory of exploration potentials ambitious plans were proposed for the next five-year period which implementation commenced in 2009 by the testing of the gas and condensate well, Dravica 1 and the drilling of the Selec-1 well in 2010. Successful results of these two wells restored trust into domestic exploration and implementation of several other successful projects followed, the most successful among them being Hrastilnica-3 well with the record high domestic production rate and Đeletovci-1. Unfortunately, by a decision of the Ministry of the Economy, Labour and Entrepreneurship, INA was left without rights to explore three most important exploration areas in Croatia - Drava, Sava and North-western Croatia, which significantly reduced the manoeuvring area in domestic exploration. After the expiry of licenses in the remaining exploration areas in 2014 INA no longer has available exploration areas in Croatia. Although exploration programme implementation continued within a limited area of INA's valid exploitation fields, only in 2013 HRK 310 million was expended onshore and offshore in the North Adriatic, which included the drilling of 6 exploration wells. In total, in the period 2009-2013 around HRK 700 million was invested into domestic exploration drilling 13 wells with the average success ration of 80% onshore and 67% offshore and 4 onshore oil fields and 1 small offshore gas field were discovered, and the Dravica-Zalata gas and condensate field in the cross-border area of Croatia and Hungary was confirmed. As a result of these discoveries the company has added 10 million boe of P2 reserves to its reserve base and upside potential of around 8 million boe was also identified which is to be proved by additional works in the coming period.

Considering the above mentioned high degree of exploration of the Pannonian Basin, possibilities for further exploration in conventional accumulations are to a large extent limited i.e. any new project requires application of original ideas, new technologies and holistic approach to exploration. Judging from experience in many "mature" world basins, we should look for alternatives outside traditional producing accumulations which means that future exploration will be focused on unconventional reservoirs with expectedly higher amounts invested for any new barrel of oil or cubic meter of gas. For this purpose a number of projects have been initiated and preparatory activities have been under way for several years; these projects representing the base of INA business plans for the next five-year period. For instance, an unconventional exploration pilot project valued around HRK 110 billion started in the last quarter of 2013 and has continued into 2014 and an extensive project for exploration of onshore shallow gas has been planned for the next five-year period.

North Adriatic can also be considered a well explored area with INA continuing with its investments in the exploration of the remaining gas prospects also in the coming years.

The Central and South Adriatic are in the focus as results of exploration activities carried out in the last several years indicated new possibilities in this area. If we win exploration rights, applying modern geological concepts with implementation of a systematic programme of additional seismic and drilling, our understanding will increase and improve. However, considering the current assessment of geological risk factors being at the level of 10 per cent, we are modest optimists regarding higher commercial quantities of hydrocarbons in the Adriatic.

Definitely the least explored area in Croatia is the Dinaride thrust belt. Although we have data from only twenty wells and 1 500 km of 2D seismic, it is known that significant world oil reserves come from similar geo-tectonic units, but it is also well known that such projects entail higher risks and large investments. In the last five-year period several regional and semi-regional studies have been done in this area based on which the Dinarides were included in strategic considerations of INA through risk sharing within some future partnership projects.

6. Conclusion

The strategic goal of INA is organic growth i.e. exploration-led growth, in which consolidation of domestic portfolio represents the backbone for achieving added value of the company. Comparative advantages of INA can be seen in its long experience in these areas, excellent results that it has achieved and the maintenance of the highest HSE standards. In this respect, one of the company's priorities is winning new exploration rights in the Croatian territory to get an opportunity to verify potential of a number of prospects identified in the past five-year period. They were identified within conventional and unconventional reservoir domains, onshore and offshore, ranging from low to very high degree of exploration risk.

Looking back at more than 60 years of domestic onshore and offshore exploration, after several millions of meters drilled, thousands of exploration, development and production wells, thousands of kilometres of seismic, tens of kilometres of gravimetric, magnetometric and geoelectric surveys we can be satisfied with the results. These results have led us to the respectable place on the map of the Central European countries, to the participation in the energy balance sheet of Croatia with more than 50%, meeting a significant percentage of oil and gas demand.

In the new circumstances when Croatian hydrocarbon market is opening and legislation in the field of exploration and production has recently undergone changes we recognise challenges and a new opportunity. Independently or in partnership with other interested oil companies we wish to demonstrate commitment to exploration of these areas, to get an opportunity to pursue a new vision, new projects and drilling of new meters, using modern, safe and clean technologies. Implementation of new exploration projects primarily means an extraordinary opportunity for young talents who have joined us through quality Growww employment programs implemented over past years. They will to a large extent be responsible for the energy picture of Croatia and be the link between legendary Naftaplín explorers and the future.

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