Problems around the evaluation and grading of oil prospects

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by

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Summary: Modern methods for the assessment of oil and gas prospects are discussed. A classification of crustal units, geotopes, which might be useful for distinguishing oil habitats is proposed. A large number of factors controlling oil and gas occurrences is enumerated and critically discussed. A graphical illustration which displays the merits of prospect proposals is introduced.

The more recently developed aspects of the oil exploration business, such as short term contracts and long term economical planning, frequently require from the oil geologist a quicker and more factual assessment of oil prospects than may hitherto have been the case.

Simple qualification by a plain method which employs terms such as «good», «fair», «poor» is generally insufficient today. The qualification must be accompanied by sound and considerably detailed argumentations in order to permit satisfactory decisions.

To make a prospect recommendation in case of uncertainty, the responsible man — usually a senior geologist — must have at his disposal not only a wide geological experience, thorough knowledge of the respective literature and informations, a good measure of common sense in matters of possibility and probability evaluation, but also a good understanding of legal, political and economical implications. He must weigh the pros and contras, know the speculative character of the arguments, the reliability of his informants, the intentions of his employers, and be capable of expressing clearly, in an often noncommittal way, his sometimes highly sophisticated opinions, so as to avoid possible misunderstandings.

As there exists no standard procedure, and as each case has to be dealt with individually, to solve the many problems is not easy and requires experience and talent.

In major oil companies where prospect and reserve assessment are almost daily routine, avoidance or, as far as possible, elimination of subjective factors is aimed at, in order that the evaluation may not be dependent on the presence of a specifically trained individual, but may, up to a certain point, be quasi mechanically repeated with approximately similar results.

Research and statistical compilation continuously endeavor to reduce the uncertainty of many factors that may support an evaluation. The evaluating geologist therefore not only has to be fully acquainted with the regional aspect of his prospect but has also to be fully aware of the latest status of research.

When dealing with a prospect, a great many factors of very unequal and often inconsistent importance must be taken into consideration.

With the increasing number of factors known to control the occurence of oil and gas, the field of variation becomes unmanageable and the application of statistics and electronic computation becomes unavoidable. With the help of this type of data processing, the results obtained are more reliable and cease to be a matter of purely personal opinion.

Mathematics thus applied in geology are a matter of administration technique and a means of codification, and allow to review and make accessible an unwieldy, immense accumulation of intricate data in order to arrive at exact qualitative statements.

It might, however, be useful in this connection to remember the limitations of statistics. No individual case can be solved by the application of statistics alone; probabilities can be calculated, but no certainties can be delivered. This is best demonstrated by the statistical age expectation applied in demography and life insurance. Every individual human being has an exact statistical age, mathematically calculated, but this statistical age expectation need by no means coincide with the true age reached by a specific individual. Wrongly applied statistics may tell lies. For the same reason, it is not recommended to apply a statistically calculated factor, e.g. «barrels of oil per cubic mile of sediment» to the evaluation of the potential reserves of an individual prospect without certain reservations and precautions. This ratio may, however, with full justification be used as the basis for the evaluation of the reserves of entire fairly well explored basins, whole continents and the whole world.

Such or similar statistically selective reserve evaluation may be applied when we try to rank the various «GEOTOPES» according to their oil and gas possibilities. Although considerable preparative work has lately been carried out in this branch of the oil science, no fully satisfying scheme has as yet been developed. The reason for this may be that not enough statistical data have been collected and sifted or that the standard basic units, the GEOTOPES, are not defined sharply enough. (Knebel, Barrabe, Brod, Perrodon)

We will try to develop here our own simplified classification of standard units.

Geotopes

GEOTOPES are big units of the earth crust — for instance, continents or substantial parts of them — which have undergone a similar and commensal sedimentological and deformational history.

One geotope may be superimposed on another, older one, some geotopes are in a stage of development or have only just started their history. In the latter case, it may not be easy to classify the unit and only a comparative study may reveal the trend of its future development.

Two basic unit groups may be distinguished: a predominantly positive and a predominantly negative group. The positive units are mainly cratonic highs, which for great lengths of geological time were exposed to erosion, the negative units are mainly depressions and basins, i.e. receptacles for water (seas, lakes) and sedimentary deposits.

Since only the negative units represent oil and gas habitats of importance, they will be discussed here.

Geotope Types (Negative Types Only)

A. *Intracratonic Basins* of structural or combined structural-erosional origin. The sedimentary fill may be continental or marine or both. Basins s.str., grabens, half-grabens, etc. Frequently undeformed but occasionally considerably tectonized. Endemic basin tectonics.

Oil and gas prospects considerable.

B. *Pericratonic Geotopes.* They accompany flexured depressions along stabilized continents (cratons) and form the links between the cratons and oceanic geotopes. Example: Mesozoic and Tertiary belts of Africa's Westcoast. As a rule little deformed. Oil and gas prospects are considerable as the sediments are almost exclusively marine.

C. *Oceanic Geotopes* or bathycratonic provinces. Occupy such parts of the crust which are permanently or semi-permanently covered by oceans. Predominantly pelagic sediments, occasional turbidites. As this type of unit is of very difficult access and rarely exposed to the surface, very little is known about its nature. Structural deformation is thought to be of minor, very local importance. Oil and gas prospects are dubious.

D. *Geosynclinal Geotopes.* They comprise the temporarily mobilized part of the crust and its borderlands and may be subdivided into the two following, sharply discriminated sub-types:

a) *Eugeosynclinal geotopes* comprising the axial portion of the geosyncline which is characterized by a very high mobility and a pronounced initial basic magmatism (ophiolites). Its sedimentary associations are typical and frequently include turbidites. Almost all of the flysch associations and major grauwacke accumulations belong to this geotope. The endemic fraction of the sediments is mainly pelagic. Reefs, where they occur, are aligned in narrow belts. The eugeosynclinal geotopes coincide with the main zones of tectogenesis and are accordingly very strongly deformed. Rocks are generally metamorphic in its deeper and inner belts and one can distinguish the non-metamorphic *Externides* from the metamorphic *Metamorphides,* both representing orogenic units. Oil and gas prospects are for many reasons considered to be low and erratic.

b) *Miogeosynclinal geotopes* link the eugeosynclines — if present at all — with the cratonic borderland. They are characterized by shelf deposits which are either carbonate/evaporites, clastics, or a combination of both. Neritic sediments predominate. Reefs, where occurring, are of the barrier type. The post-depositional tectonic deformation, although present in most cases, is as a rule much less pronounced than in the adjacent eugeosynclinal geotope. The miogeosyncline is furthermore the site of marked magmatic differentiation, granitization and volcanic activity. All these phenomena are narrowly connected with orogenic processes affecting the subcrustal portion of the miogeosyncline. It is highly probably that more than fifty percent of the oil and gas resources of the world are bound to this type of geotope.

E. *Post-Orogenic Geotopes* originate from deformations tending to re-establish the crustal gravity and pressure equilibrium which had been thoroughly disturbed by the preceding orogenetic diastrophism. This rehabilitation movement as a rule extends not only over the whole geosynclinal area but also encroaches widely on the bordering cratonic units. The late orogenic magmatism persists deeply into these posthumous phases and volcanism is equally characteristic for these units and periods. Peri-orogenic troughs (foreland depressions), grabens and minor basins are the main representatives, and as their formation coincides with the rise and destruction of mountains, the fill of the basins is mainly clastic.

The sediments are characterized by their frequent facies changes in time and space; they may have been deposited in a marine as well as in a paralic or continental environment. A typical association of this geotope is the molasse.

Oil and gas prospects are fairly favourable, although frequently somewhat erratic and of minor extent.

Each geotope has beside its characteristic sedimentary association, the LITHOTOPE, a specific tectonic deformation pattern, the TECTOTOPE. It also frequently comprises a particularly developed magmatic and volcanic rock association, the MAGMATOPE. We may therefore and for other reasons assume that the gravimetric, the magnetometric and the seismological picture of the various geotopes show, although on a statistical basis only, different grains.

It is furthermore very likely that the distribution and occurrence of bitumina, i.e. the OLEOTOPE, is governed by characteristics of the geotope. Until such time, however, as their innate relationship and the factors controlling it are better known through further research, statistical data will have to be employed in order to reduce the risks of exploration.

The controlling factors of the Oleotope

Classification and grading of oil and gas prospects relies on a number of factors which we know or assume to be either directly or indirectly indicative of the presence of oil or gas.

Some of the factors, such as the presence of source rocks, are fundamentally important, others, like the presence of salt water springs, are only possible clues and of a secondary nature.

To each factor therefore, we attribute a certain weight, which could, for the present purposes, be expressed in a scale. As such a scale is highly speculative, however, and as it is not the sum of the individual factors, but their groupwise co-occurrence and association which is important, we will in the following list give only very general qualifications, such as:

W I	fundamentally important
W II	fairly important
W III	of accessory importance

Beside this innate weight, each factor receives a knowledge qualification, based on the question: how much of the respective factor is known through a) reliable observation, b) experiment, c) theoretical supposition, d) extrapolation, e) analogy, f) guess, g) nothing at all. This knowledge rating can in each individual case be expressed as a percentage of the full knowledge.

The following table lists mainly geological factors of the geotope. The factor is defined, an assessment of its weight and in most cases a short critical remark concerning the actual status of our knowledge is given. We do not aim at completeness.

The list may be of some use as a reminder when checking upon the prospects of a specific case.

List of factors controlling or possibly indicating the presence of oil and gas

THE GEOTOPE

A. The Oleotope — Direct Indications

1. *Natural oil indications,* oil seeps, gas seeps, etc. W III

They are of restricted, accessorial importance. Many geotopes with plenty of oil seeps have never yielded commercial production; conversely, others have become big production areas without ever showing a surface indication.

2. *Artificial oil indications.* W II

It must be remembered that artificially established oil indications, such as oil shows produced by commercially non-productive wells, have to be carefully evaluated. Lack of production may be due to a) insufficient exploration activity, b) poorly chosen well location, c) poor technical handling of the drilling. Additional exploration under new insights may possibly be recommended.

On the other hand, activities in semi-explored areas need not necessarily be successful, as is sufficiently demonstrated by the fact that in the United States more money is lost each year in vain efforts to develop non-commercial fields than in wildcat drilling proper. There is no doubt that basins with evident but innately inadequate oil or gas reserves are a frequent phenomenon.

For propagandistic reasons, both natural and artificial oil indications are often vastly exaggerated in their indicative value. An oil seep is an excellent starting point for wishful thinking.

3. *Tarsands, Oil Sands, Impregnations.* W III

Although they may occasionally accompany oil pools, they may on the contrary also represent the residual of oil now lost or, according to other interpretations they may, in part at least, have originated in a slightly different way from the oil formation proper and need thus not be accompanied by commercial oil pools. They are of regional rather than local importance. Compare Athabasca tarsands, East-Venezuelan tar belt, Madagascar tar sands, etc.

4. *Asphaltites.* W III

Dikes of asphaltite (gilsonite, albertite, etc.) were originally considered as having been formed independently from liquid oil or from gas, but more recent studies (Forsman) in the Uintabasin (USA) suggest that there is a close relationship between the occurrence of oil pools and such dikes.

5. *Oil source rocks.* W I

The ubiquity of oil and gas suggests that oil source rocks are very common and widespread. In spite of great efforts, however, no safe procedure for the recognition of source rocks has as yet been established. A recently developed method (Bray), has so far only been applied in a few specific cases and has failed to receive worldwide recognition. Oil source rock studies deserve the fullest attention of researches and prospect assessors should be fully abreast of the status of such research. The possibility to recognize source rocks by any method, however, does not imply recognition of the commerciability of such occurrences. It is in this connection that oil shales, for instance, may be classified as a kind of underdeveloped source rock of little actual commercial value.

B. The Oleotope — Indirect Indications

1. *Bituminous rocks, oil shales, etc.* W III

Sediments with bitumenous components are very common and occur in almost all sedimentary basins. They may be bound to certain phases of the sedimentary history of certain habitats and occasionally a particular sequential position can be established. Very little, however, is known about the extent to which the formation of bituminous rocks is a separate process developing on parallel lines with the genesis of oil or — more unlikely — how far the two processes, following one upon the other, may represent only phases of one and the same evolution. Further studies on bituminous sequences, whether marine or not, oil bearing or not, are strongly recommended (Bitterli).

2., 3., 4. *Sulphur-, saltwater-, gas springs, etc.* W III

Circumstantial evidence shows that oil occurrences are regulary accompanied by one or more of these indications. They are, however, accidental and may occur quite independently from any oil. The general aspect of the area and a careful examination of every individual occurrence must contribute to a final conclusion. The report of such an indication without any additional information has little diagnostic meaning: methane may originate from coal, H_2S from volcanic emanations and saltwater may be just connate rockwater without any oil accompaniment.

5. *Mudvolcanoes.* W III

The worldwide distributional pattern indicates that mudvolcanoes are bound to very specific, generally post-Paleozoic geotopes with numerous outstandig features. They usally occur in young, alpidic troughs with rheotectonic tendencies and are therefore frequently connected with diapirism. Although mud volcano bearing structures are unfavourable for structural reasons, methane and oil emanations from mud volcanos can be taken as favourable regional, but not local, indications. Mud volcano basins are found in very prolific oil provinces such as Transcaucasia, British Borneo, N-Sacchalin, Sumatra, Trinidad, Rumania, Sicily, etc.

C. The Lithotope

1. *Size of the area. Sedimentary volumes.* W I

The extent of the available sedimentary area, one of the few factors generally known exactly, is of course very important. The bigger the area of a little explored geotope, the bigger the chance that commercial oil or gas accumulations may be encountered. The same applies for the cubic mileage of sediments. However, as stated in the introduction, a large cubic mileage of sediments alone is by no means a guarantee for the occurrence of oil or gas, any one of the lithotope factors listed below may be much more important than the extent and the volume of sediments.

2. *Distribution and persistence of the presumed oil formation.* W I

For practical reasons, we designate here as oil formation any paying oil or gas bearing formation, whether it be a source or a reservoir formation. A general compilation study of the surface and, if available, the subsurface information, as well as of the distributional pattern of oil and gas indications, may allow conclusions about this important factor. Where direct observations are lacking, theoretical considerations will have to fill the gap. The miogeosynclinal or intracratonic basin geotopes for instance will as a rule have a more regular distribution pattern of oil formations than post-orogenic geotopes.

3. *Thickness of the oil formation.* W III

Very little is known about a possible relationship between the thickness and the commercial yield of an oil source formation. A relatively thin source formation with an appropriate composition and history may yield much more oil than, for instance, a thick source rock sequence unfavourably developed or lacking sufficient overburden. Here again applies what we have said under C1.

4. *Marinity of the sediments.* W II

Circumstantial evidence suggests that most of the oil source rocks are of marine origin. Such an obvious statistical statement is probably basically untrue. The writer believes that oil may equally well have been formed in non-marine, lagoonal, lacustrine and paralic deposits, but that a) this type of environment is much less frequent and widespread than marine environments and b) being a near surface environment its chances of survival are much smaller than those of marine deposits.
The extensive occurrence of non-marine bituminous rocks like most oil shales (Uintabasin, Scotland, S-Brazil, etc.) may be considered a feature pointing in this direction.
The marinity of sediments is principally recognized by its fossil content, but more recently geochemical methods, such as the borium determination (Ernst) seem to provide practical means for further progress in this direction.

5. *Facies, facies pattern and facies persistence.* W I

Modern facies and isopach maps prepared for individual, crucial formations often show very clearly the interrelationship between a particular facies and the pattern of oil and gas occurrences. There is no doubt that some lithotopes — for instance euxinic deposits — are more promising oil habitats than others. Although this type of facies study seemingly promises the quickest way to the elucidation of oil occurrence problems, it provides only circumstantial, i.e. statistical solutions instead of fundamental ones until such time as the question of the geochemical determination of oil source rocks is finally resolved.

6. *The absolute age of the sediments.* W III

The formation of oil and gas takes a long time. Not only is a considerable overburden and compaction necessary before oil forms, but the initial phases of migration and accumulation apparently are time-consuming also. It is generally agreed among oil scientists, based on recent studies, that no oil could have been formed in post-Pliocene time. At the other time end, allthough Cambrian gas and oil deposits are well known, the probability that primary oil and gas accumulations are destroyed increases with age. For sediments deposited, let us say between early Paleozoic and Lower Pleistocene, however, the time factor can be neglected.

7. *Reservoir rocks: Distribution, extent, persistence.* W I

Allthough the presence of reservoir rocks is of fundamental importance, it should not be forgotten that the best reservoir is of no use if not enough oil has been formed in the basin. Facies studies are the principal means for delineating the probable presence, location and size of reservoir bodies. The knowledge of the general basin configuration and its borderlands may help to evaluate theoretically the probable presence of adequate reservoirs. In this connection, one should remember that recent sedimentological studies have demonstrated the presence of sandstone bodies (deep sea sands, turbidites) in other words, potential reservoirs, in quite unexpected places.

8. *Reservoir rocks: Porosity, permeability.* W I

The physical character of the presumed reservoir, whether it is a clastic or a carbonate rock, is eminently important as regards the economical result of an oil or gas venture.

9. *Secondary porosity* W II

The presence of secondary porosity features can, with the necessary precaution, be deduced either from the stratigraphical history of the geotope or from specific tectonical aspects. Seismological evidence also may give some clue.

10. *Spatial relationship between oil source formations and reservoirs.* W II

This is a seldom considered but obviously important point.

11. *Caprocks.* W I

In most sedimentary basins they form, as a rule, an essential part of the sedimentary sequence and their presence or absence can be inferred from facies maps. Evaporites are favored caprocks and thin layers may prove to provide a sufficient seal. The caprock qualities of massive carbonate rocks is very erratic and has to be evaluated from case to case.

12. *Stratigraphical and lithological traps.* W II

This kind of trap is probably present in every lithotope, but its exact location is difficult to establish even by the most modern means. The stratigraphic sections generally exposed along the edge of the basin, which may be supported by features discovered in wildcats inside the basin, may reveal possible porosity changes. Geophysical methods may under favorable circumstances help in the discovery of reefs, diapiric masses and buried ridges, all of them frequently accompanied by porosity belts. Again the facies/isopachite map is an excellent source for the discovery of such invisible features.

13. *Situation of a prospect in relation to producing areas.* W III

The presence of a commercially productive field within a lithotope under exploration naturally is a great incentive to evaluate its prospects highly. The distance of influence of an oilfield upon prospects in its vicinity, however, varies greatly depending on the type of lithotope involved, and its fundamental facies grid size, and must be evaluated from case to case. The direction in which the prospect is situated in relation to the productive field may also play a very large part in its evaluation. In a very general way it may be said that with a distance of about 30 to 50 km the neighborhood factor loses its weight and other factors become dominant.

D. The Biotope

Aqueous environments which are poor in oxygen, and therefore favourable for the initial formation and preservation of oil source material, may be inhabited by a highly specialized and adapted association of animals and plants. Such an association, which we will call SAPROCOENOSIS may, together with its habitat, the SAPROTOPE, become fossilized and thus be preserved. Very little so far is known about such animal associations living in sapropelic mud, but it is possible that future studies might recognize in them useful clues for the discovery of oil source formations.

E. The Tectotope

1. *The tectonical style of the tectotope.* W II

The tectonical style, which describes the manner of folding, thrusting, faulting, etc., of the geotope, is to a large extent controlled by the lithotope. The primary presence of oil and gas obviously has little to do with the style of deformation; however, the presence of adequate oil and gas traps is intimately connected with it.

A thorough understanding of the deformational style can be acquired by field survey and geophysical work.

2. *Intensity and persistence of deformation.* W II

A proper scale for the measurement of the intensity of deformation has not so far been found, but could probably be developed. The intensity varies laterally and with the depth and it may be either of regional or of purely local importance.
If the structural trends are buried below unconformable or overthrusted cover and are not accessible to geophysical exploration, structural variations and changes must be deduced from general regional studies.
Although it seems reasonable to assume, that the stronger the deformation (overthrusts, etc.), the smaller the chances for survival of oil and gas pools, many instances are known where considerable hydrocarbon accumulations have been preserved in structurally complex and even chaotic zones (Rumania, Canada, Algerian Atlas, etc.). The presence in such areas of intercalated highly plastic sediments may often have helped to prevent the destruction of such accumulations. Compare also paragraph E_6.

3. *The paratectonical deformation.* W II

Whereas paragraph E_2 is mainly concerned with the compressional tectonical deformation (orthotectonics) with lateral transport predominating, the paratectonical deformation is for the most part caused by vertical transport, i.e. transport along faults. Faults are important as potential traps and have to be fully considered when exploration wells are located.

4. *Frequency and arrangement of structures.* W II

Not only is it important to know the frequency of folds, fault-blocs, faults, etc., but also their situation in relation to the geotope as a whole. Structures along the basin edge may be more adequately located for oil drainage and accumulation than structures in the center of the basin.

5. *Type and size of structural traps.* W I

Here geophysical studies are assential. Surface structures, particularly in rheomorphically deformed geotopes, need not coincide with deep-seated sub-surface structures. Fault planes are rarely plane and do not continue to infinite depths.

6. *Rheotectonic structures.* W I

Structures that were not caused by orogenic processes but by the differential plastic behaviour and compaction (including mudflows) of rocks may be called rheotectonic. Saltdomes, diapirs, compaction structures, intraformational gliding folds, etc., belong to this group and are characteristic for certain geotopes. A combination of rheotectonic with orogenic deformation is frequent and may, as is the case in Rumania and Poland, lead to very complicated but nonetheless oil and gas bearing structures (see paragraph E_2).

F. *Coincidence and Time Relation of Geological Processes (The Chronotope)*

The formation of oil and gas accumulations requires that a number of independent geological processes or their phases, for instance the formation of oil and the formation of structural traps occur in well timed, chronological sequence. Depending on the type of process involved, the following factors may be distinguished:

1. *Chronological sequence of oil genesis, compaction, diagenesis and lithification.* W II

   Since the formation of crude oil requires a considerable length of time, indeed as much as one million years, the mostly simultaneous processes of compaction and lithification which presumably involve many geochemical processes about which little is known, may influence to a large degree the results of the oil generation process.

2. *Chronological sequence of migration and deformation.* W I

   Only structures formed prior to or simultaneously with oil migration can act as traps. In most parts of the earth and at all times, continuous although very gradual crustal deformations have taken and are still taking place. Consequently a continouos shifting and dislocation of the mobile liquid and gaseous contents must be assumed, and only in well closed traps is a temporary equilibrium achieved. Particularly revealing in this respect are diapiric structures which unlike most orogenic structures have grown very slowly and over a great length of time. The rate of growth can in many cases be deduced from the degree of attenuation of the suprajacent formations. The influence of gradual deformation upon synchronous oil and gas migration has been demonstrated in many cases.

3. *Chronological sequence of migration, erosion, and the formation of cap rocks.* W II

   The formation of stratigraphic traps and their preservation is controlled by a corresponding chronological sequence of trap formation and migration.

4. *The chronological role of hydrodynamic processes.* W II

   Crustal deformations, whether orogenic or rheotectonic in origin, cause not only dislocation of oil and gas, but also of the ever present water. An equilibrium between the various fluids and gases, once established, can very easily be disturbed by the revival of diastrophisms and it may take a long time before a new equilibrium is reached. Areas out of their actual hydrostatic equilibrium are well known from pressure measurements and the fact that hydrodynamic traps distort the normal picture of water — oil distribution can be seen in many areas.

5. *Geothermal factors.* W III

   A few cases have been reported where a high thermal gradient, now as a rule completely smoothed out but originally caused by intrusive igneous bodies or other heat producing centers has influenced crude oil accumulations during or after migration. Other cases are known where magmatic heat has originated the distillation of bitumina in oil shales and similar rocks. Oil seeps in various countries, such as Scotland, Argentina, S-Brasil, Mexico, Madagascar and others, which are bound to igneous contacts, have erroneously been taken as indications for the presence of commercial oil quantities. In some of these places (Sosneado in Argentina) a few barrels of heavy oil have indeed been produced.

G. The Technotope

It comprises such factors as arise from technical exploration, location and production problems.

1. Depth of drilling object.
2. General technical exploration problems.
3. Geophysical exploration problems.
4. Drilling problems.
5. Available quantities of oil and/or gas. Reserves.
6. Quality of the products.

H. Geographical Factors (Transport, etc.) Accessotope

I. Economical and Marketing Factors Mercuriotope

K. Political and Legal Factors Lexopolitope

The Grading of oil and gas prospects

All factors compiled in the preceding chapter contribute to the overall evaluation of the prospect. Although no standard measure or scale exists for the grading of a prospect, a classification on the basis of relative values can be made by comparing a sufficient number of prospects.

It is very difficult to obtain — even with the support of statistics — a coordinated picture considering the many factors involved, because many of these factors are interdependent or not commensurable if measurable at all. Not only do we have to deal with the fundamental qualitative weight of each single factor but also with the degree of our knowledge in each specific case.

For purposes of demonstration, we introduce here a triangle (Fig. 1) into which we insert all our prospects. Their assumed importance and the optimum expectation in million barrels is indicated by a symbol. In the right hand corner of the triangle we put those prospects of which our geological knowledge is nil. Towards the left our knowledge increases in grades of ten. If our knowledge is absolutely negative and detrimental to the evaluation, we arrive at the lower left hand corner, where we may, for instance, place symbolically an exposed deep-rooted crystalline mass («granite»). If the knowledge is definitely favourable to the oil evaluation, we arrive at the upper left where symbolically we could place a commercially producing oil field.

It is obvious that once a prospect is properly placed in the graph, each additional piece of information obtained means a move of the symbol to the left: to the upper left if the information is favourable (positive Roman numerals), to the lower left it is unfavorable (negative Roman numerals).

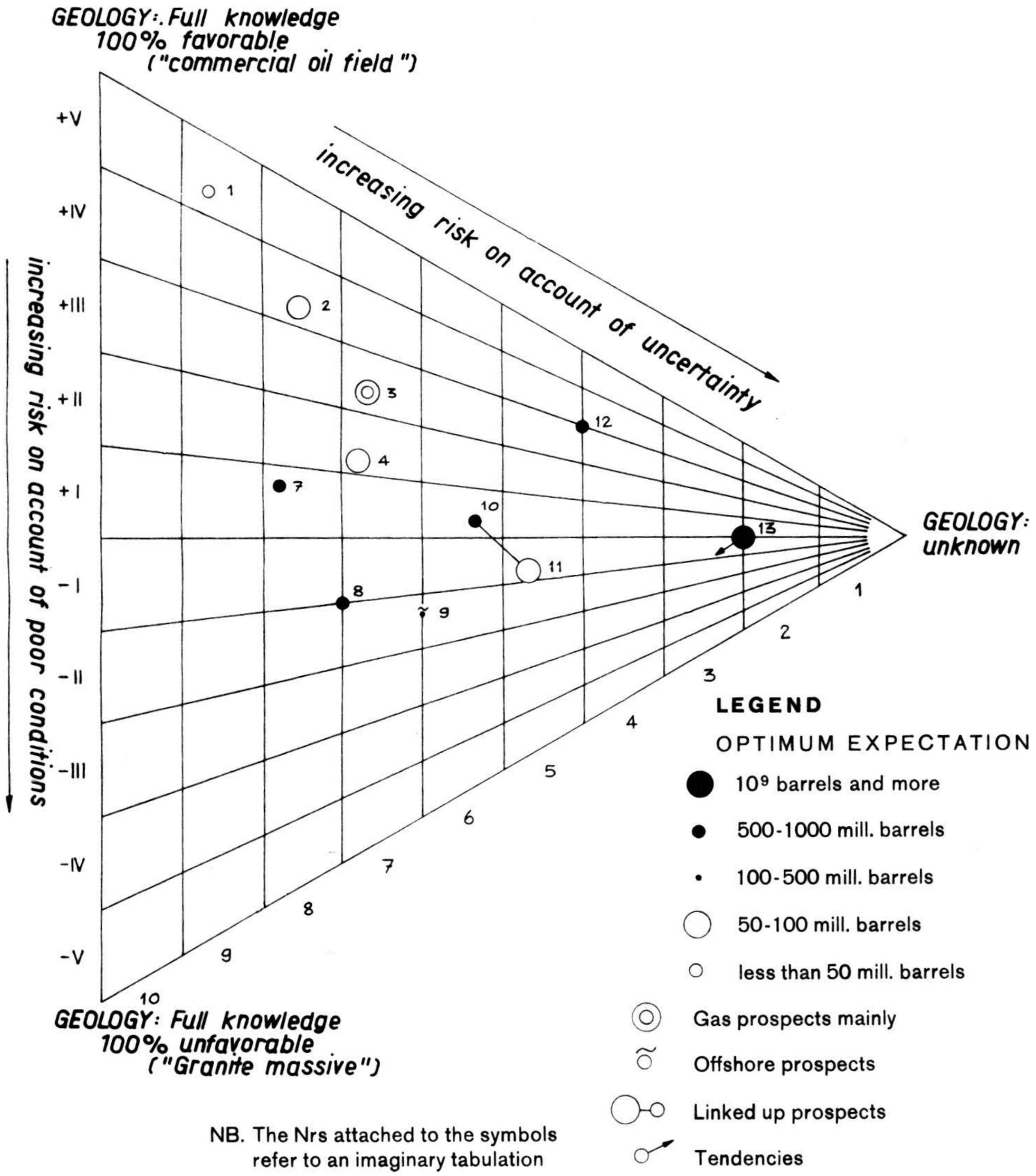

Fig. 1

The location and qualification of a prospect can also be given textually, e.g.: «the XYZ prospect in India is 700 mill. bbls., class 5/II,20 sq miles.» The size of the prospect — for instance, a permit under consideration — must be indicated.

The evaluation of the expectation or the reserves either follows the usual method, given for instance by Moody, 1961, (reserves) or, in less known areas (expectations) calculations are combined with the study of analogous cases and extrapolations are made.

High risk ventures with great possibilities but low probabilities are clearly separated in the graph from low risk ventures with high probabilities.

The graph does not lay claim to being helpful in the evaluation of one single, specific case. It may help the geologist, however, to select from a number of suggestions an object which both from the point of view of economy and of policy meets the requirements of a given oil enterprise.

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