RESERVOIR MANAGEMENT

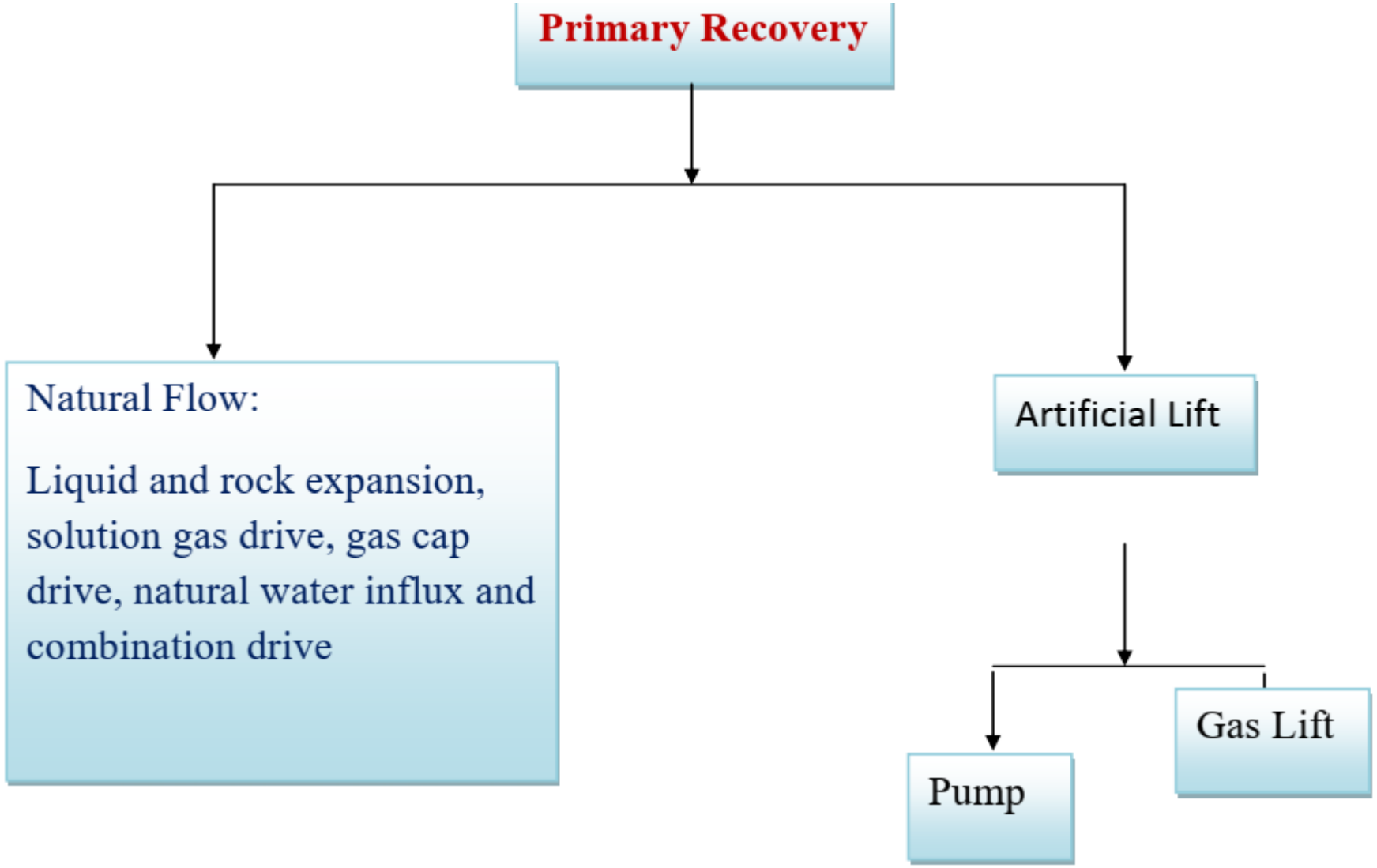
Dr. Raed H. Allawi

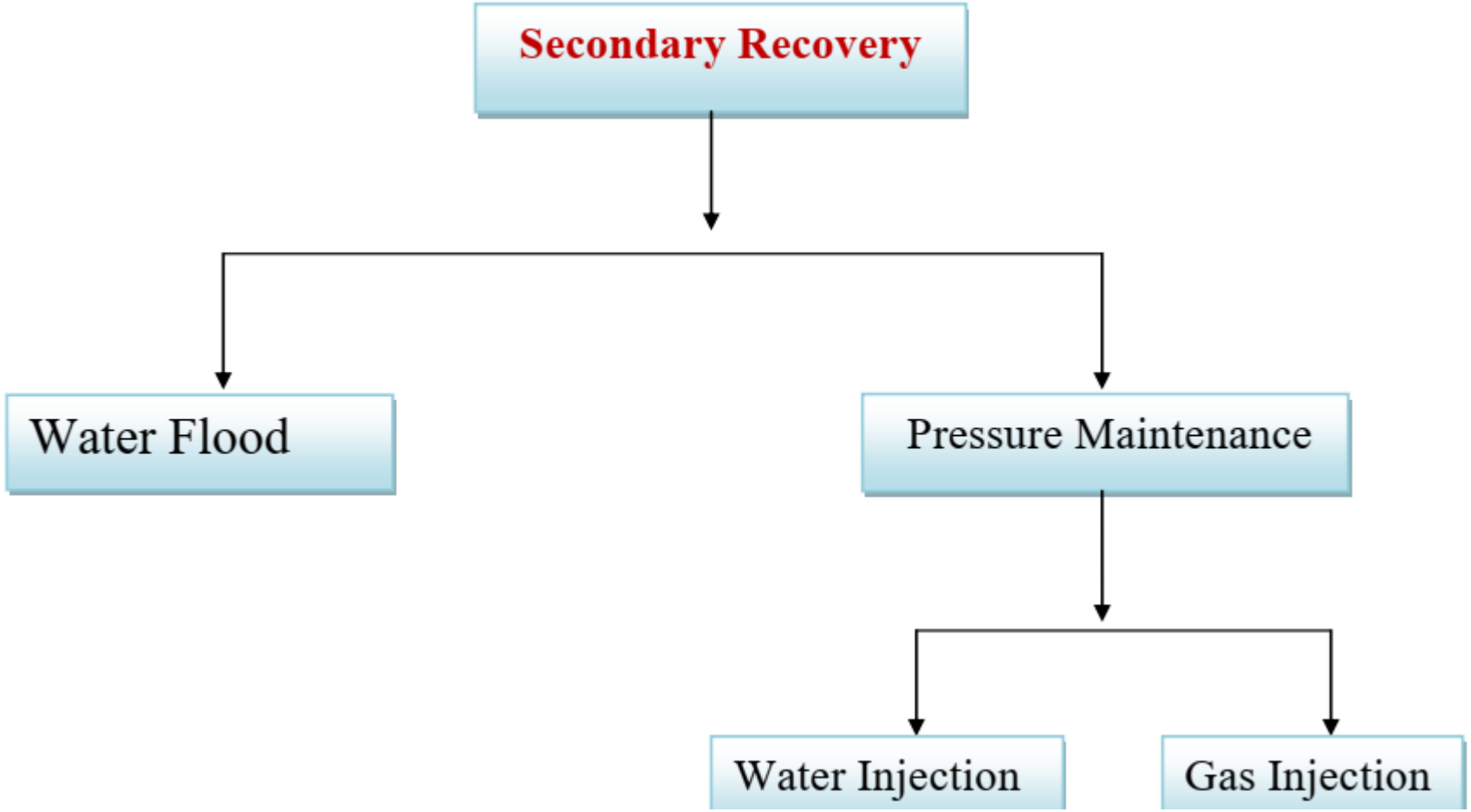
INTRODUCTION

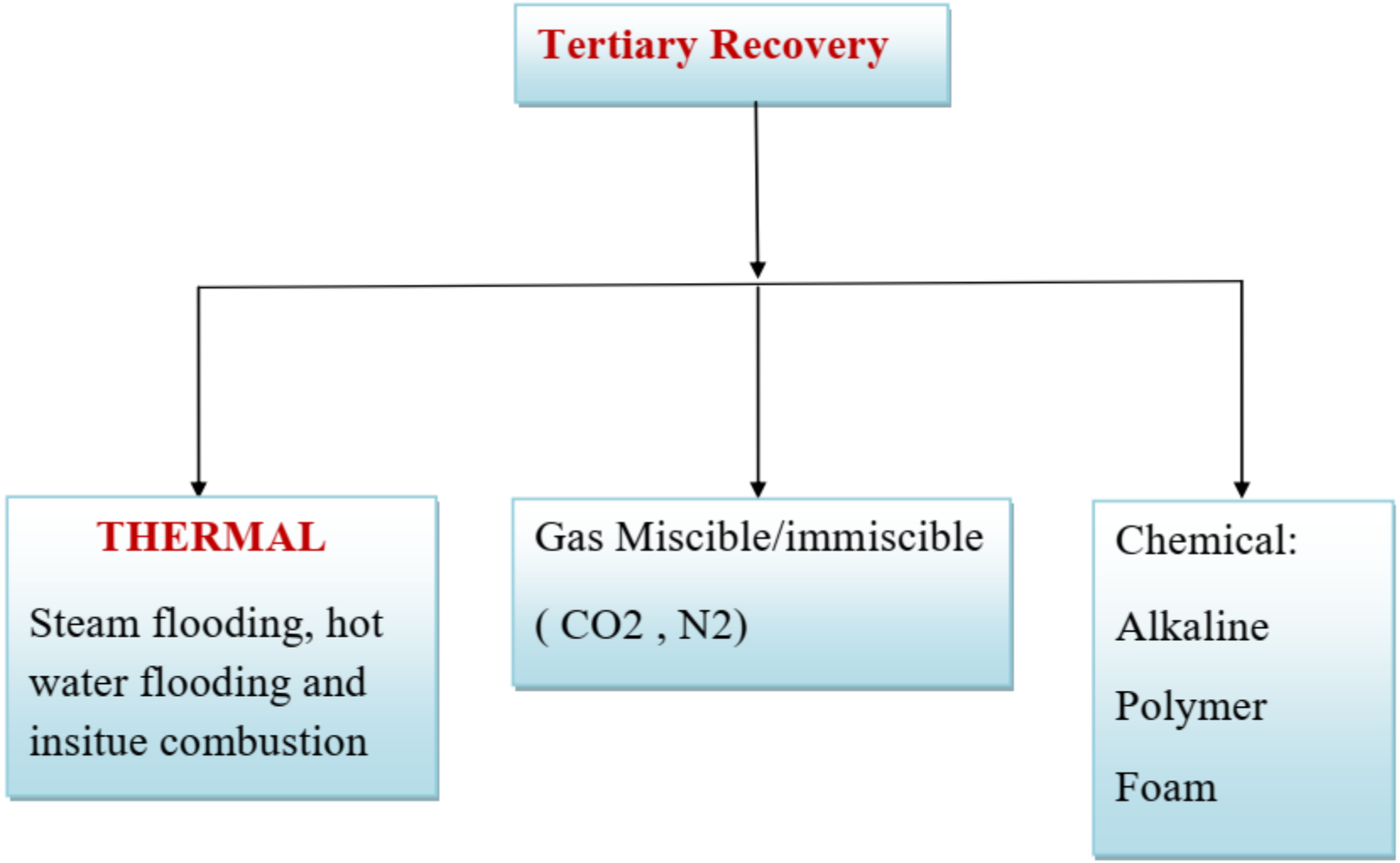
- As we know the reservoir‟s life begins with exploration that leads to discovery, which is followed by delineation of reservoir, development of the field, production by primary, secondary, and tertiary means, and finally to abandonment as shown in figure(1).
- So integrated, sound reservoir management is the key to a successful operation throughout the reservoir life.

Figure (1) Reservoir Life Process

- Even with tertiary means a vast amount of hydrocarbon remains unrecoverable, and the reserves being declined, but due to sound reservoir management a significant additional amount being added to the US reserves.




Secondary Recovery
Water Flood
Pressure Maintenance
Water Injection
Gas Injection


Tertiary Recovery
THERMAL
Steam flooding, hot water flooding and insitue combustion
Gas Miscible/immiscible
(CO2 , N2)
Chemical:
Alkaline
Polymer
Foam

DEFINITION OF RESERVOIR MANAGEMENT:

- There are many definitions for **Reservoir Management** one of them is: using all available resources (human, technological and financial) to maximize profits from a reservoir by optimizing recovery while minimizing capital investments and operating expenses.
- **Reservoir Management** involves making certain choices. Either let it happen or make it happen, we leave it to chance to generate some profit from a reservoir operation without doing deliberate planning or we can enhance recovery and maximize profit from the same reservoir through sound management practice.

OBGECTIVE OF RESEVOIR MANAGEMENT

- The prime objective of **Reservoir Management** is the economic optimization of oil and gas recovery, which can be obtained by the following steps:

  1. Identify and define all individual reservoirs in a particular field and their physical properties.
  2. Deduce past and predict future reservoir performance.
  3. Minimize drilling of unnecessary wells.
  4. Define and modify (if necessary) well and surface systems.
  5. Initiate operating controls at the proper time.
  6. Consider all pertinent economic and legal factors.

- Thus the basic purpose of **Reservoir Management** is to control operations to obtain the maximum possible economic recovery from a reservoir based on facts, information, and knowledge.
- The following questions – and – answer provides **Reservoir Management** philosophies.

1. When **Reservoir Management** should starts?

The ideal time to start managing a reservoir is at its **discovery**.

Provides a better monitoring and evaluation tool, but also costs less in the long term run. For example, a few early drill stem (**DST**) and **logs** that can indicate the size of a reservoir, if it is of limited size, drilling of unnecessary wells can be prevented

2. What, How and When to collect data?

To answer this question, we must follow an integrated approach of data collection involving all functions from the beginning. Before collecting any data, we should asked the following questions:

- Are the data necessary, and what are we going to do with these data? What decisions will be made based on the results of these data collection?
- What are the benefits of these data, and how do we devise plan to obtain the necessary data at the minimum cost?
- The reservoir team should prepare a coordinated reservoir evaluation program to show the need for data requirements, along with costs and benefits.

3. What kinds of questions should be asked if we want to answer the answer in the process of **Reservoir Management?** Some example questions follow:

- What does the answer mean?
- Does the answer fit all the facts; why or why not?
- Are there other possible interpretations of the data?
- Where the assumptions reasonable?
- Are the data reliable?
- Are additional data necessary?
- Has there been an adequate geological study?
- Has the reservoir been adequately defined?

SYNERGY AND TEAM

- Successful **Reservoir Management** requires synergy and team efforts. **Reservoir Management** is not synonymous with reservoir engineering and /or reservoir geology. Success requires multidisciplinary team efforts. The team must work together to ensure development and execution of the management plan. Figure (2) show the team of **Reservoir Management.**

Figure (2) Reservoir Management Team

All development and operating decisions should be made by the **Reservoir Management team.** It is not necessary that all decisions be made by a reservoir engineer, in fact, a team members who considers the entire system, rather than just the reservoir aspect, will be a more effective decision maker.
A team approach **Reservoir Management** can be enhanced by the following:

- Facilitate communication among various engineering disciplines, geology, and operation staff by :
  a. Meeting periodically.
  b. Interdisciplinary cooperation in teaching each other's functional objectives.
  c. Building trust and mutual respect.

- To some degree, the engineers must develop the geologist's knowledge of rock characteristics and depositional environment, and geologist must cultivate knowledge in well completion and other engineering tasks, as they relate to the project at hand.

- Each team member must maintain a high level of technical competence.

- The team members must work as a well – coordinated " basket ball team" rather than "relay team". Reservoir engineer should not wait on geologist to complete their work and then start the reservoir engineering work.

- Today, it is becoming a common for large reservoir studies to be integrated through a team does not guarantee an integration that leads to success. Team skills, team authority, team compatibility with line management structure, and overall understanding of the **Reservoir Management process** by all the team members are essential for the success of the project. So “synergy means that geologists, geophysicists, petroleum engineers and others work together on a project must effectively and efficiently as a team than working as individual “ Team members prepare **Reservoir Management** plan and define their goals and objectives by involving all functional groups.

- The plan is then presented to production manager; and after receiving the manager's feedback, appropriate changes are made, next the plan is published and all members follow the plan.

❖ The team members performance evaluation is conducted by their functional heads with input from the team leader and the production manager.

❖ Teams are rewarded recognition / cash award upon timely and effective completion of their tasks.

INTEGRATION OF GEOSCIENCE & ENGINEERING

Synergy and team concepts are the essential elements for integration of geosciences and engineering. It involves people, technology, tools, and data see figure (3). Success for integration depends on:

- Overall understanding of the reservoir management process, technology, and tools through integrated training and integrated job assignments.
- Openness, flexibility, communication, and coordination.
- Working as a team.
- Persistence.

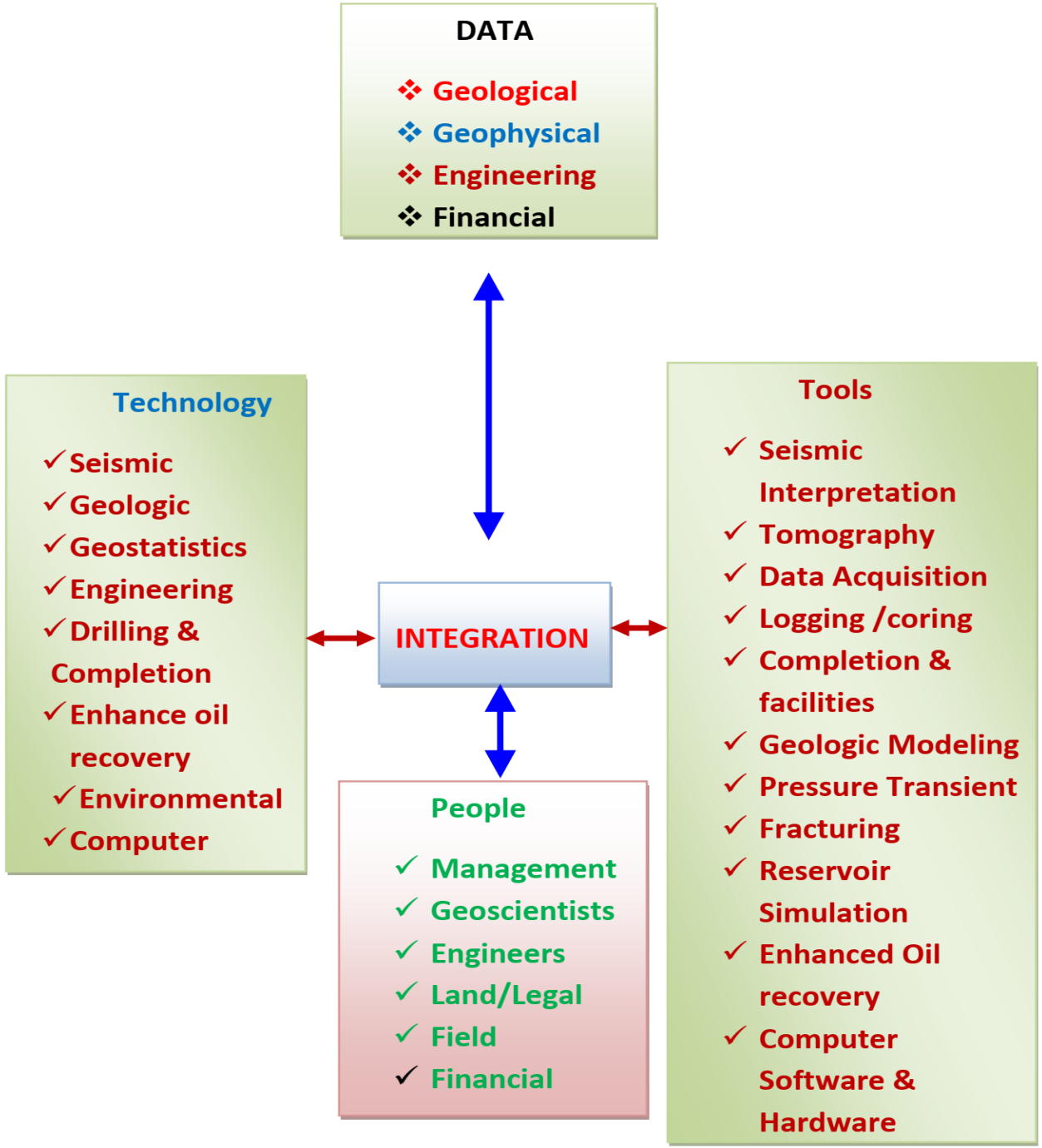

DATA
Geological
Geophysical
Engineering
Financial
Technology
Seismic
Geologic
Geostatistics
Engineering
Drilling & Completion
Enhance oil recovery
Environmental
Computer
INTEGRATION
People
Management
Geoscientists
Engineers
Land/Legal
Field
Financial
Tools
Seismic Interpretation
Tomography
Data Acquisition
Logging /coring
Completion & facilities
Geologic Modeling
Pressure Transient
Fracturing
Reservoir Simulation
Enhanced Oil recovery
Computer Software & Hardware

Figure (3)

INTEGRATION EXPLORATION AND DEVELOPMENT TECHNOLOGY

New development in computer hardware, technology, and software are enhancing integration of multidisciplinary skills and activities; this development change the way of oil companies works.

For example advancements in 3-D seismic acquisition and processing are credited to the massive number – crushing super computer.

3-D seismic data along with computer- processed logs and core analysis characterize or describe more realistically and accurately the reservoir maps along with rock and fluid properties and production / injection data to simulate reservoir performance and to design depletion and development strategies for new and old fields.

THE RESERVOIR MANAGEMENT PROCESS

- The modern **Reservoir Management** process involves establishing a purpose or strategy and developing a plan, implementing and monitoring the plan, and evaluating the results. Figure (4). None of the components of the reservoir management is independent of the others. Integration of all these are essential for successful reservoir management.

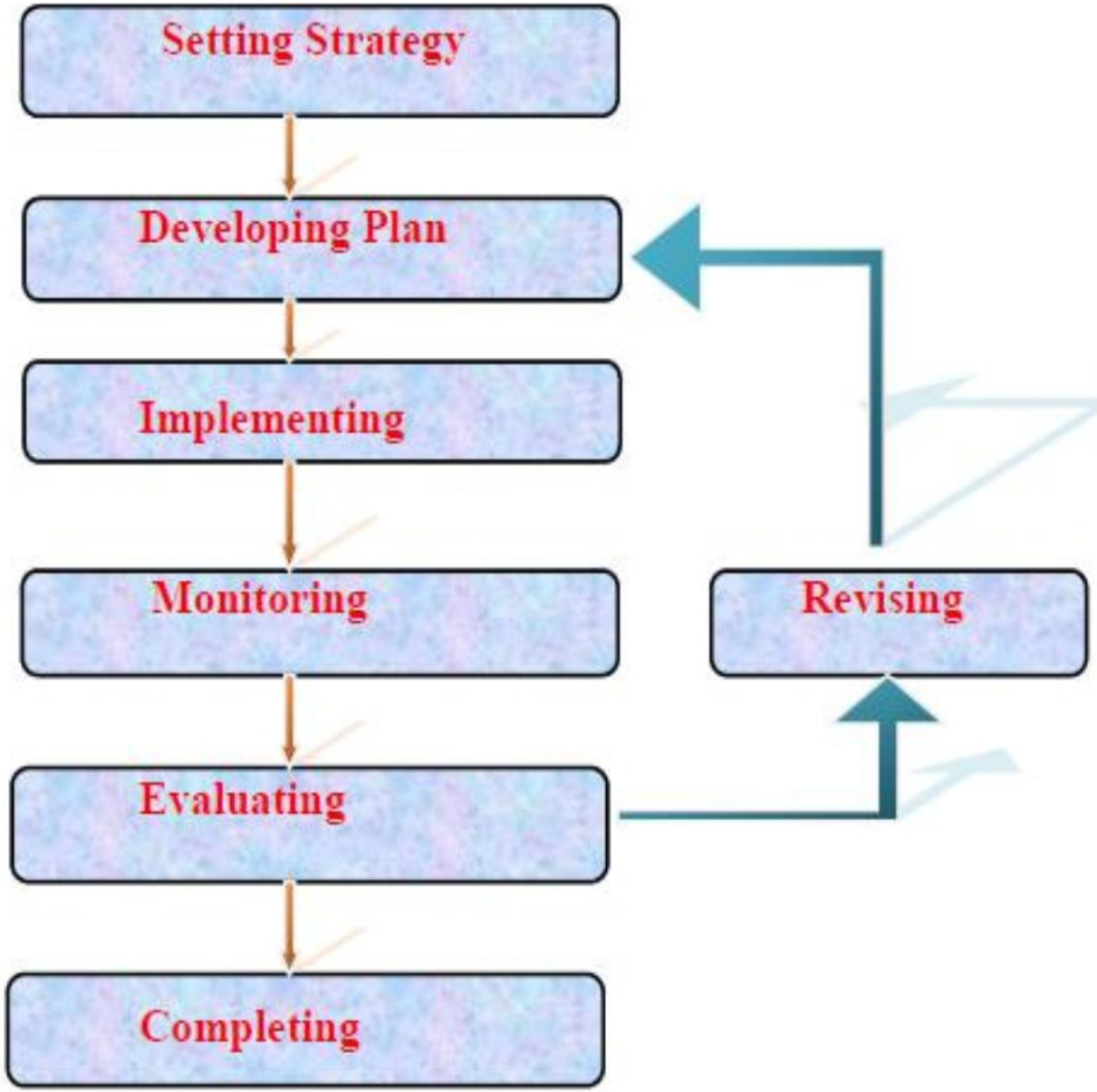


Figure (4) Reservoir Management Process

- Setting a **Reservoir Management strategy** requires knowledge of the reservoir, availability of technology, and knowledge of the business, political and environmental climate.
- Formulating a comprehensive management plan involves depletion and development strategies, data acquisition and analysis, geological and numerical model studies, production and reserves forecast, facilities requirements, economic optimization, and management approval.
- Implementing the plan requires management support, field personal commitment, and multidisciplinary integrated teamwork. Success of the project depends upon careful monitoring / surveillance and through,, ongoing evaluation of its performance. If the actual behavior of the project does not agree with the expected performance, the original plan needs to be revised and the cycle (i.e. implementing, monitoring, and evaluating) reactivated.

SETTING GOALS:

- Recognizing the specific need and setting a realistic and achievable purpose is the first step in reservoir management.

  The key elements for setting a reservoir management goal are :

  1. Reservoir characteristics

  2. Total Environment.

  3. **Available Technology**

  Understanding of each of these elements is the pre requisite to establish short – and – long – term strategies for managing reservoir

RESERVOIR CHARACTERISTICS:

The nature of the reservoir being managed is vitally important in setting the management strategy. Understanding the nature of the reservoir requires a knowledge of the geology, rock and fluid properties, fluid flow and recovery mechanisms, drilling and well completions and past production performance . see figure(5)

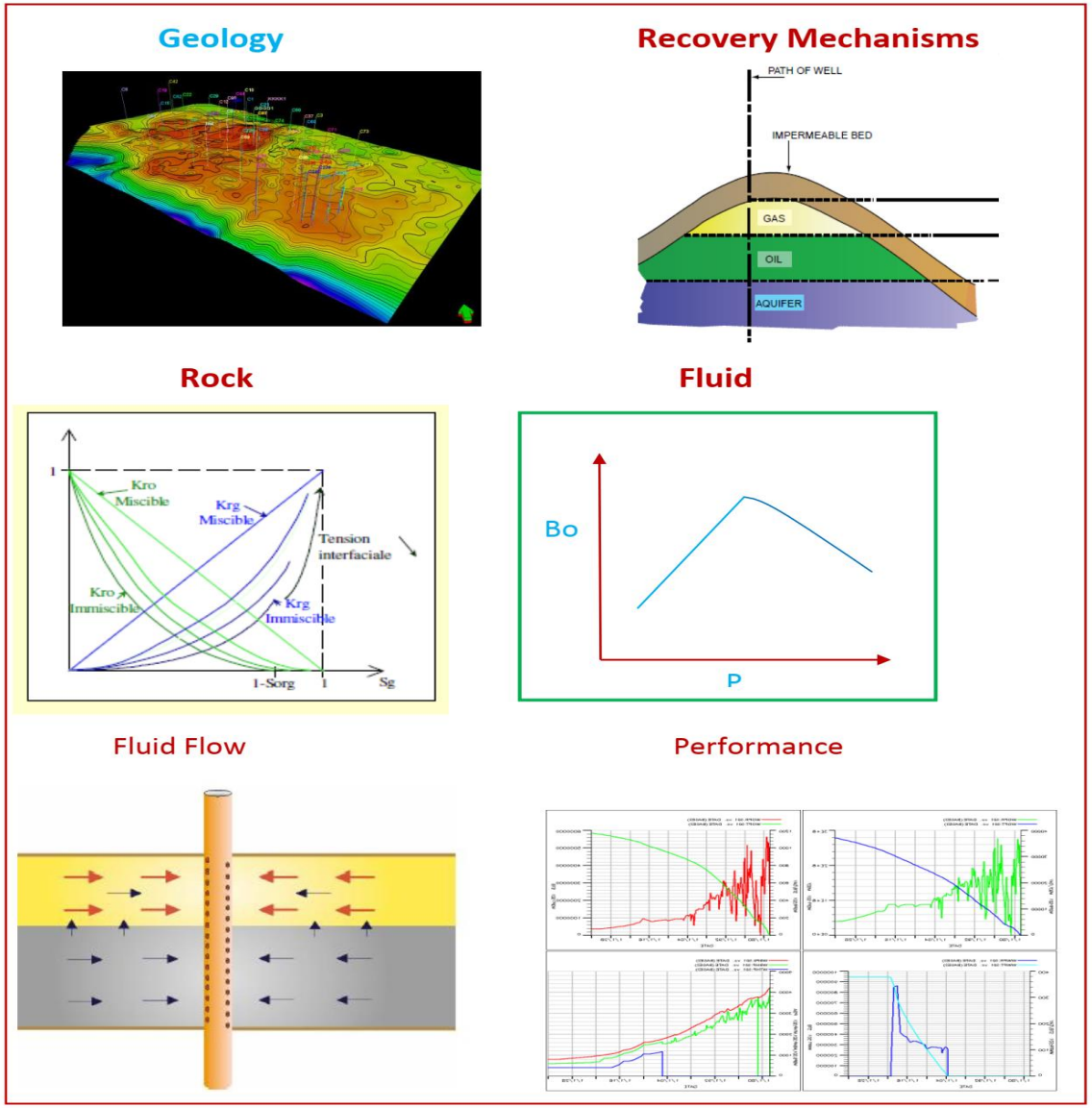


Figure (5)

TOTAL ENVIRONMENT:

Understanding of the following environments is essential in developing management strategy and effectiveness:

- Corporate – goal, financial strength, culture, and attitude.
- Economic – business climate, oil/gas price, inflation, capital, and personnel availability.
- Xial – conservation, safety, and environmental regulations.

TECHNOLOGY AND TECHNOLOGICAL TOOLBOX

- The success of reservoir management depends upon the reliability and proper utilization of the technology being applied concerning exploration, drilling and completions, recovery process and production. See Table (1)

Geophysics	Geology	Production Engineering	Reservoir Engineering
2 D Seismic	Core Description	Economics	Management
3 D Seismic	Thin Section	Data Acquisition & Management	Log Analysis
Cross –Hole	Microscopic	Well stimulation	Transient Well tests
Tomography	Image Analysis	Pipe Flow Simulation	Conventional Core Analysis
Vertical Seismic	X- ray	Well bore stimulation	CT. Scan. NMR
Profile	Stable Isotope Analysis	Nodal Analysis	Fluid Analysis
Multicomponent Seismic	Depositional Models		Decline Curve analysis
Shear Wave	Map, Cross sections		Material balance
Logging	Remote Sensing		Waterflood
			Reservoir Simulation
			Geostatistics
			EOR Screening
			EOR Technology
			Expert System

Table (1)