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Various methods for examining geology are explained with pictures.

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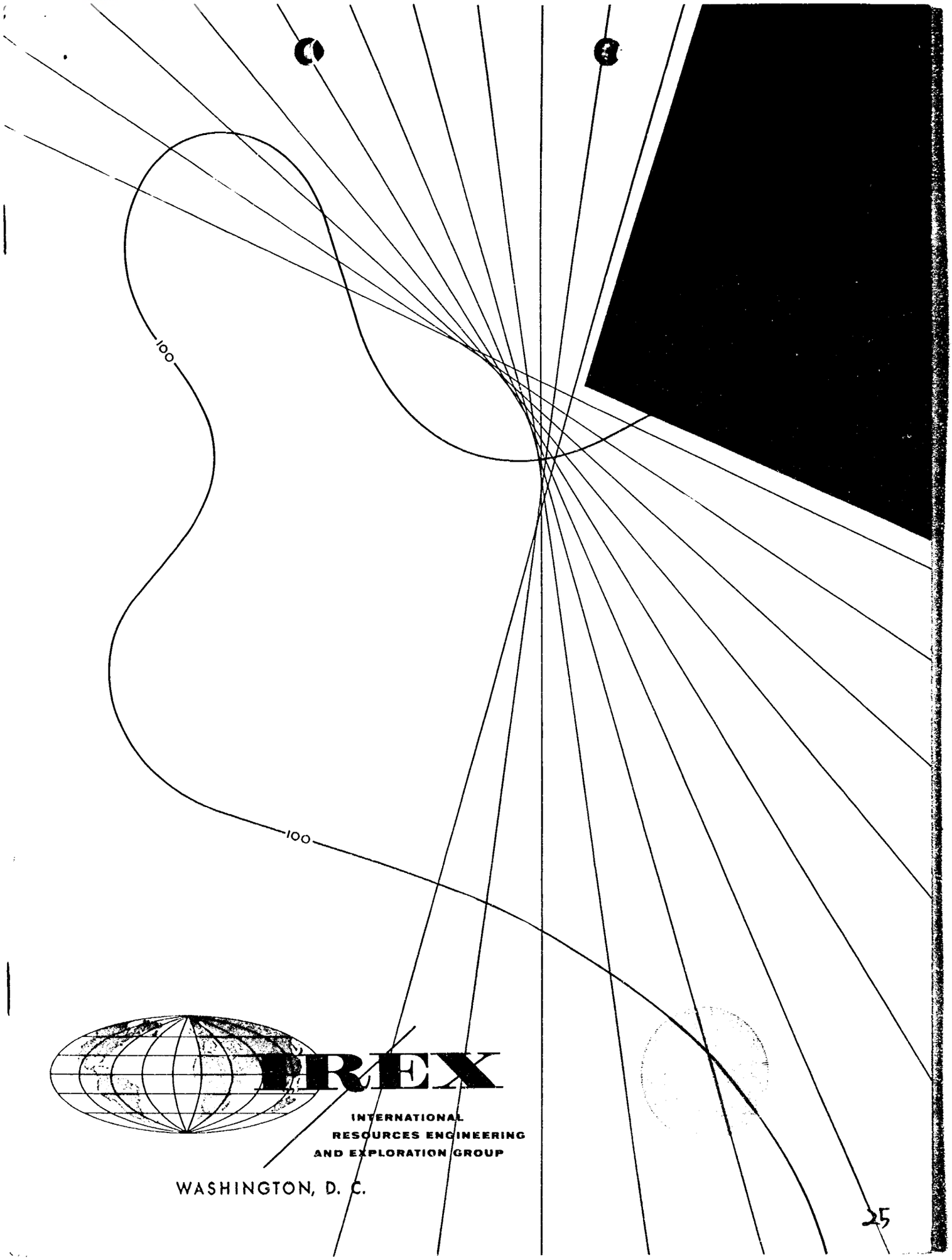

IREX

INTERNATIONAL
RESOURCES ENGINEERING
AND EXPLORATION GROUP

WASHINGTON, D. C.

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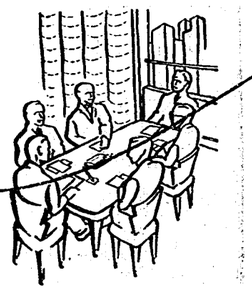


PLANNING

AIR PHOTOGRAPHY

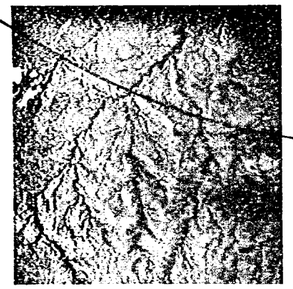
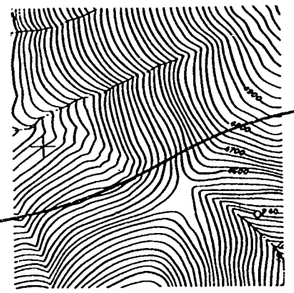
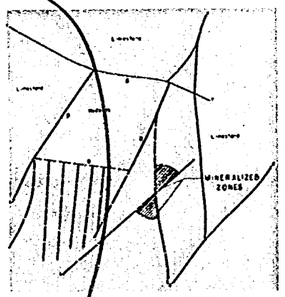


PHOTO MOSAICS



TOPOGRAPHIC MAPPING

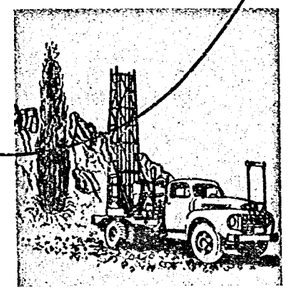
PETROLEUM



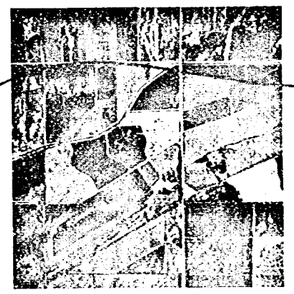
MINERAL DEPOSITS

FORESTRY

WATER SUPPLY



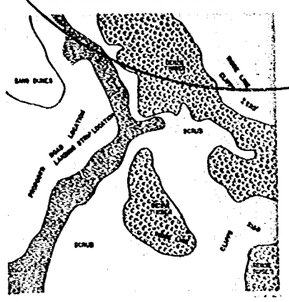
GEOPHYSICS

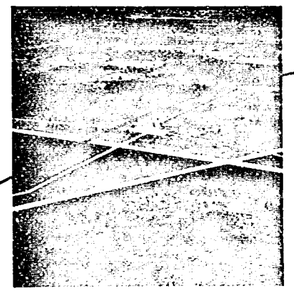


SOILS

SITE SELECTION

TERRAIN ANALYSIS

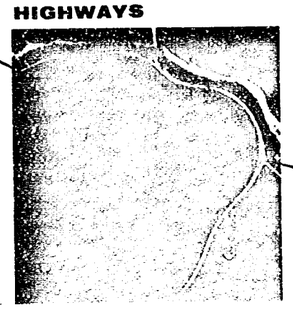




AIRFIELDS

RECLAMATION

HIGHWAYS



RESOURCES MANAGEMENT PLAN

JACK AMMANN PHOTOGRAMMETRIC ENGINEERS, INC.

Jack Ammann Photogrammetric Engineers, Inc. are specialists in air photography, photogrammetry and mapping. During twenty-three years of service they have established a world-wide reputation as a leader in these fields.

A staff of 200 specialists is maintained who employ a wide variety of aircraft, cameras, steroscopic plotting instruments and related equipment. Projects have been completed covering more than 2,000,000 square miles of the earth's surface for both public and private clients.

Offices of Jack Ammann Photogrammetric Engineers, Inc. are in San Antonio, Texas; Denver, Colorado; and New York City.

GEOPHOTO SERVICES

Geophoto Services specializes in photogeologic evaluation and detailed surface mapping.

Geophoto, with a professional staff of over 100, is the largest organization of its kind in the world. The firm has prepared geologic maps of more than 1,250,000 square miles in the United States and fourteen other countries.

The main offices of Geophoto Services are in Denver, Colorado. Geophoto Explorations, Ltd., for foreign operations, also has its headquarters in Denver. Field offices are maintained wherever Geophoto Explorations field parties operate throughout the world. Offices of Geophoto Services, Ltd. are in Calgary, Alberta, Canada.

Geophoto's world-wide experience and reputation assure the highest level of professional service in photogeologic evaluation and detailed surface mapping.

BROWN & BLAUVELT, CONSULTING ENGINEERS

Brown & Blauvelt has handled a wide variety of engineering projects from preliminary planning and reports through construction supervision.

Their record includes the design of $128,000,000 of major highways; reclamation studies for 500,000 acres of wasteland in Indonesia; Sampson Air Base (U.S.A.F.); site engineering of Puerto Ordaz and Ciudad Piar in Venezuela; dam construction supervision for Niagara Mohawk Power Co.; tax maps for Poughkeepsie, N. Y.; industrial engineering for ALCOA, Koppers Co., Jones and Laughlin and others; and parks, piers, waterfront developments, sewage and waste disposal plants.

The staff includes 200 engineers, city planners, draftsmen and surveyors. Offices are maintained in New York, Boston and Woodbury, N. J.

PLANNING AND EXECUTION OF NATURAL RESOURCES SURVEYS BY MODERN PHOTO-ANALYTIC PROCEDURE, REQUIRES THE SERVICES OF MANY SCIENTIFIC AND ENGINEERING SPECIALISTS

IREX was formed to fulfill the world-wide need for an organization specifically equipped to perform all aspects of natural resources surveys and engineering design. It coordinates under one experienced management the activities of the many specialists required for swift, accurate and economical performance of these surveys.

IREX is a unique organization. It offers not only a scope of services of unparalleled breadth, but these services are performed by outstanding specialists in each field . . . Services offered by IREX, either individually or in any required combination include:

IREX

INTERNATIONAL RESOURCES ENGINEERING AND EXPLORATION GROUP

- **PLANNING**
  - Joint Advisory Boards
  - Economic Analysis
  - Survey Organization
- **PHOTOGRAMMETRY**
  - Air Photography
  - Photo Mosaics
  - Planimetric Maps
  - Topographic Maps
  - Tax Maps
  - Cadastral Maps
- **FIELD SURVEYING**
  - Geodetic Surveys
  - Cadastral Surveys
  - Control Surveys
- **RESOURCES SURVEYS**
  - Terrain Analysis
  - Engineering Geology
  - Petroleum Geology
  - Mineral Deposits
  - Forest Inventory and Management
  - Range Inventory and Management
  - Land Classification
  - Soil Conservation
  - Agriculture
  - Surface and Subsurface Water
- **GEOPHYSICAL EXPLORATION**
- **ECONOMIC STUDIES**
- **ENGINEERING**
  - Reclamation
  - Airfields
  - Dams
  - Water Supply
  - Waste Disposal
  - Drainage and Irrigation
  - Harbors and Canals
  - Tunnels
- **ROUTE SELECTION & DESIGN**
  - Highways
  - Railroads
  - Pipelines
  - Power Lines
- **CITY & SITE PLANNING**
  - Industry
  - Housing
  - Recreational Facilities
- **PROCESS ENGINEERING**

The IREX Group includes one of the nation's oldest and largest firms of photogrammetric engineers, the foremost organization of consulting photogeologists in the world and consulting engineers of world-wide reputation. These firms are supplemented by staff consultants outstanding in their respective fields. IREX offers the services of experienced pilots, photographers, photogrammetrists, geophysicists, geologists, foresters, agronomists and engineers to plan and execute resources surveys and design for projects of any scope.

AIR PHOTOGRAPHY—THE KEY TO MODERN SURVEYS

The scene above shows a remote, inaccessible region. It typifies many areas of the world where untold hidden wealth in natural resources may be discovered, evaluated and developed.

The world is inadequately mapped, yet to continue with conventional ground survey methods used in the past would require more time and technical manpower than is available. The necessity for a new approach is clear.

Air photography opens new vistas; it transforms the arduous and time-consuming toil of ground studies into rapid three-dimensional analysis. Air photography is undeterred by the obstacles of terrain and climate—jungles, deserts, canyons or unscaled peaks offer no resistance to the camera.

It is the key to modern low cost, high accuracy natural resources surveys. Air photography has gained broad acceptance for studies in geology, forestry, hydrology, agriculture, land classification, highway planning, and many other engineering studies, and is now universally recognized as the method for topographic mapping.

Air photographs preserve a permanent record that can be used for many varied purposes—a permanent record that shows minute detail registering features often overlooked by ground scrutiny.

Whether for small-scale reconnaissance or for large-scale analysis, the use of air photography supplemented by field studies offers *more accurate results* in *less time* and at *lower cost* than conventional methods.

NATURAL RESOURCES PLANNING AND DEVELOPMENT

The development of natural resources is a complex problem requiring a comprehensive many-sided program. It demands a coordination of diverse knowledge, obtained from many scientists and engineers.

IREX offers this coordination. Through a joint advisory group it is possible to inter-relate the variety of functions and processes. IREX provides consulting services in both the planning and the execution of natural resources exploration, evaluation and production.

As the first step in the overall appraisal of an area or country, rapid reconnaissance surveys determine the potential natural resources and their location. Ground surveys are used to control and supplement the photographs. Economic analysis then defines which resources can profitably be developed according to the present and future markets and production costs.

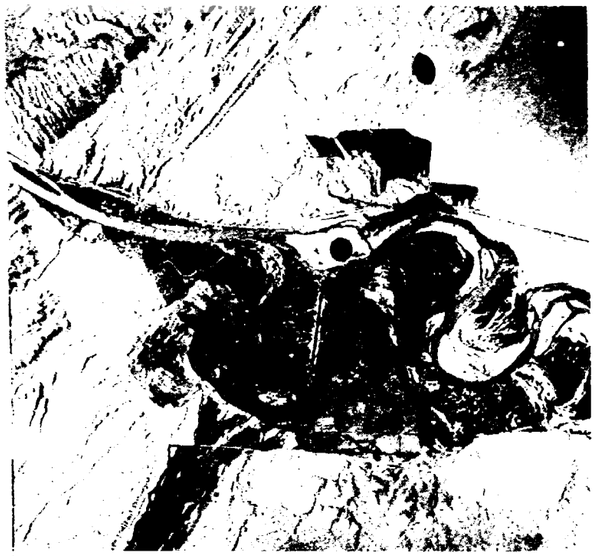
The second step is a detailed mapping of the selected resources. Topographic maps of limited areas are required; access roads and railroads are located; water and power supplies are analyzed in detail. Plans are prepared for construction of necessary transportation, processing plants and allied buildings. The location of towns in conjunction with the industry is decided. Finally, the projects proceed into construction which must be closely supervised to protect the accrued investment.

Years can be telescoped by using modern methods. IREX offers the advantage of outstanding scientific performance and the coordinated services of a group of experts. This coordination assures the best use of time and accumulated technical data.

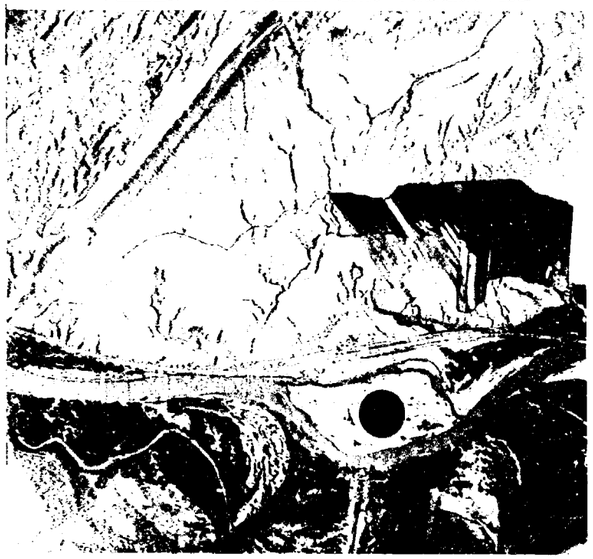
If some parts of a resources development program have been completed, IREX will organize these portions then plan and execute the remainder.

If only one specialized study or service is desired, IREX will gladly contract for its selected advisory members and consultant experts. Even when operations are to be performed one by one, establishing a master plan is the key to economical resources development.

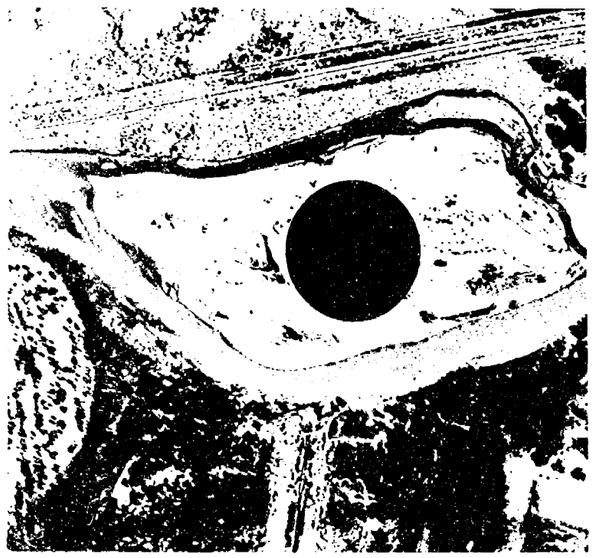
IREX PROVIDES EXPERIENCE AND INTEGRATION



High altitude photographs used for reconnaissance evaluation and mapping cover up to 100 square miles per photograph.



Medium altitude photographs are used for many resources studies.



Low altitude photographs are used for detailed studies.

AIR PHOTOGRAPHY

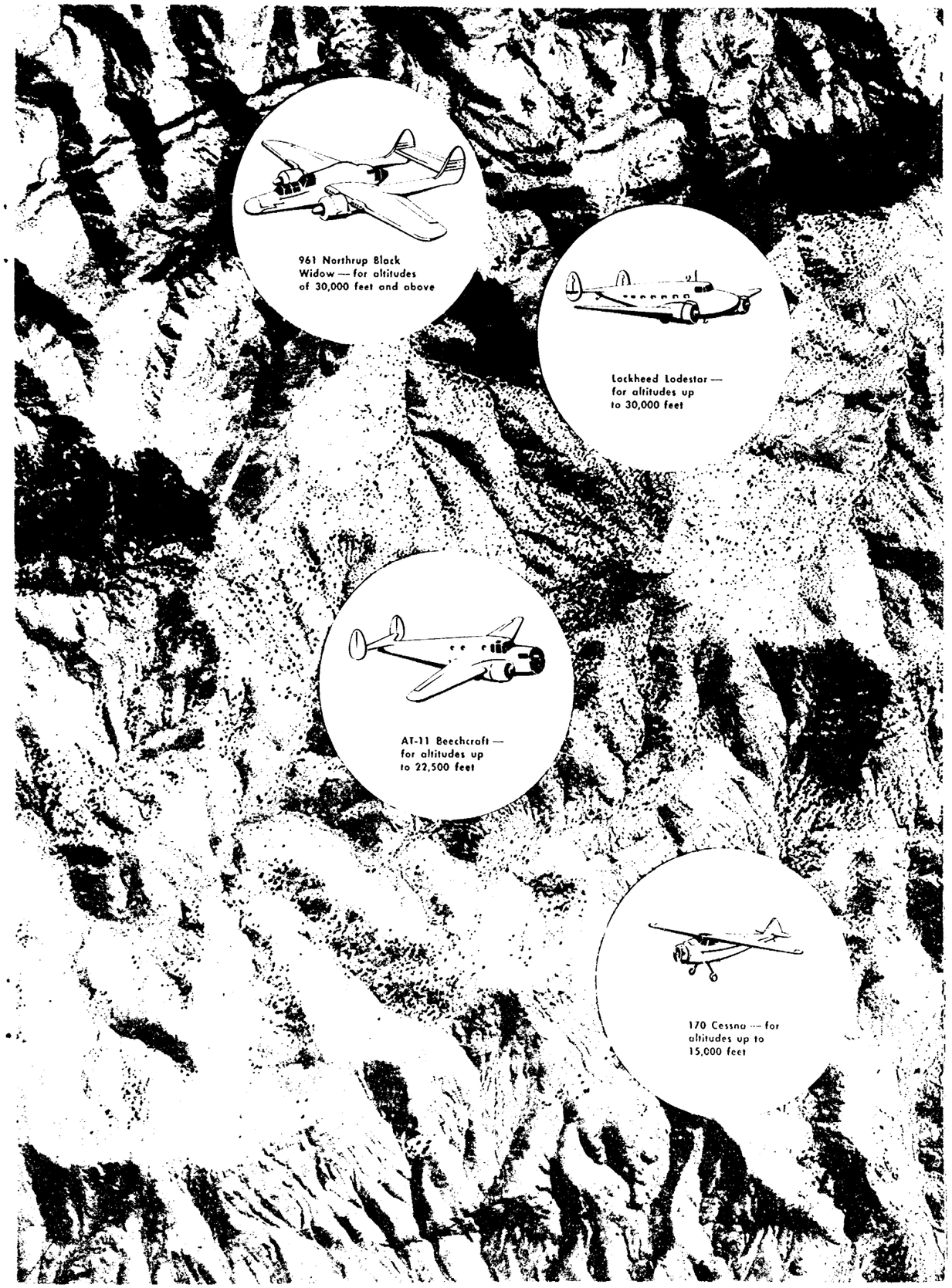
IRLN has the necessary equipment and personnel with world-wide experience to accomplish the various kinds of photography required for all types of projects.

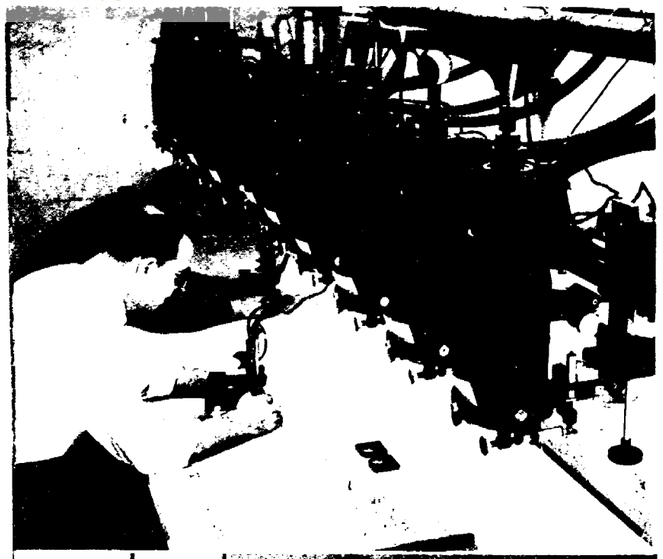
Air photography planned and executed to meet the specific requirements of individual projects assures economical operations and accurate evaluation of resources data.

The IRLN Group has available a fleet of aircraft which includes planes for every type of work. Illustrated on the opposite page are four types of aircraft now in use.

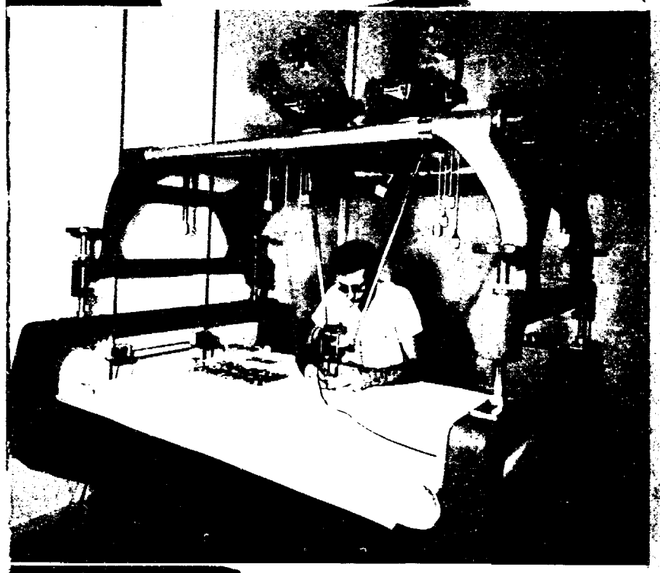
PHOTO MOSAICS

Photo mosaics, which provide a composite picture of a project, are frequently used in the early stages of planning. They are an excellent base for developing overall plans of project operations and for compiling resources data.

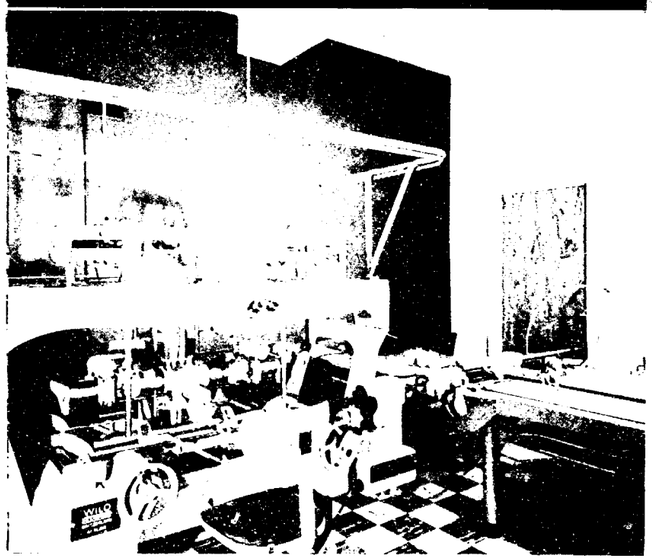




The Multiplex



The Kelsh Plotter

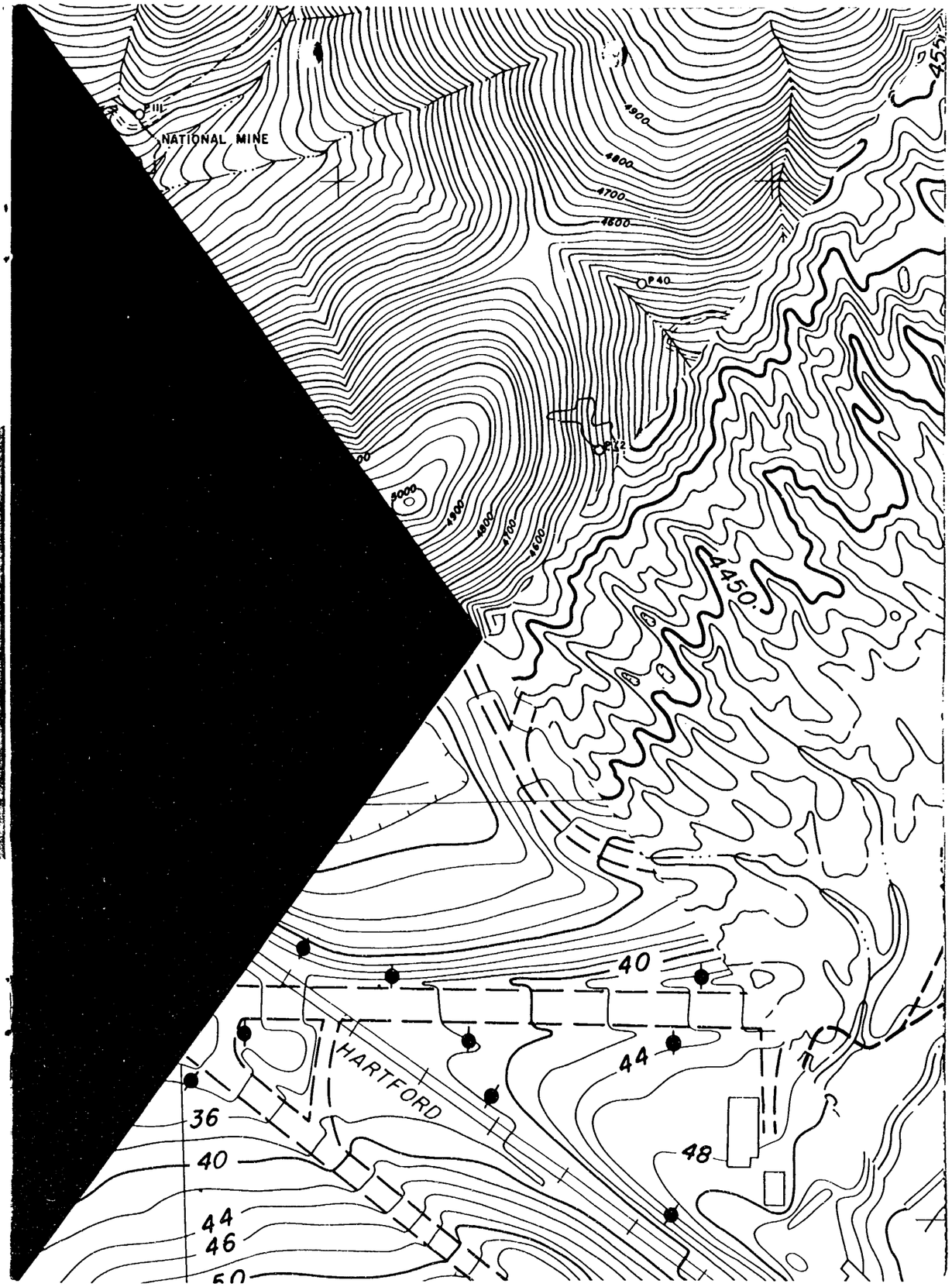


The Wild A-7 Autograph

TOPOGRAPHIC MAPPING

Photogrammetric engineering makes it possible to produce reliable topographic and other maps to meet the requirements of exploration, development and engineering projects in a relatively short time.

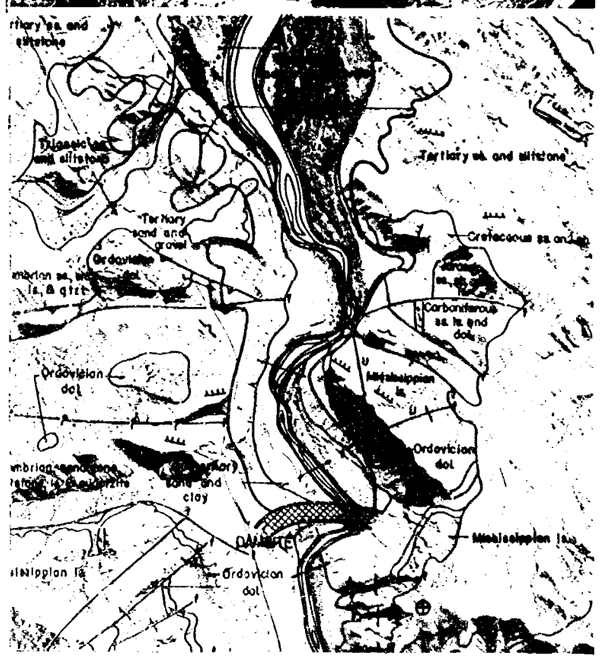
The IREX Group owns and operates all three of the recognized standard types of stereoscopic plotting instruments.

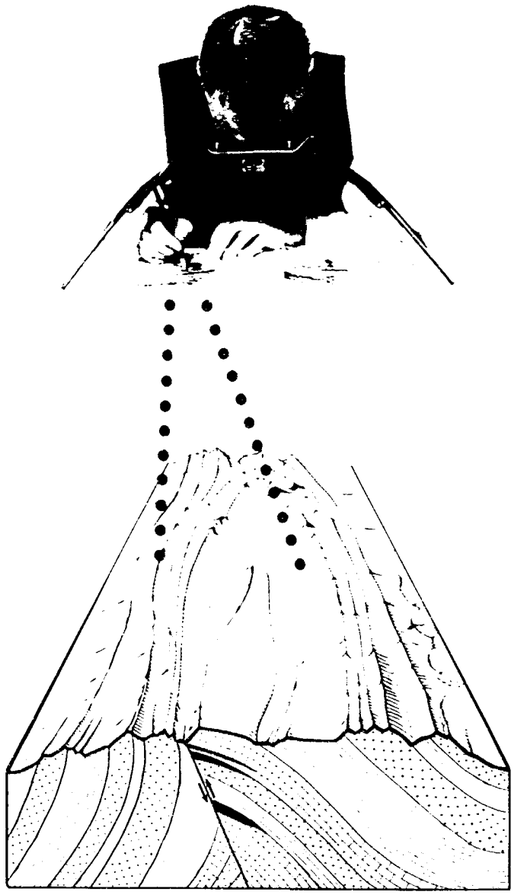


GEOLOGIC EVALUATION

A regional geologic map provides a basic foundation for natural resources evaluation. It shows the types of rock and the deformation they have undergone. A study of the map indicates the best prospects for petroleum or mineral exploration, allowing the selection of the most promising areas for more detailed study. A regional geologic map also furnishes fundamental data for allied fields of hydrology, soils, forestry and engineering.

Few countries have adequate maps of this type. To accomplish such mapping by conventional field methods requires years of arduous work. By means of air surveys and subsequent photogeologic evaluation the regional geologic map can be constructed rapidly at low cost.





Field parties work in any part of the free world to make detailed surface studies or check the photogeologic maps.

ENGINEERING GEOLOGY

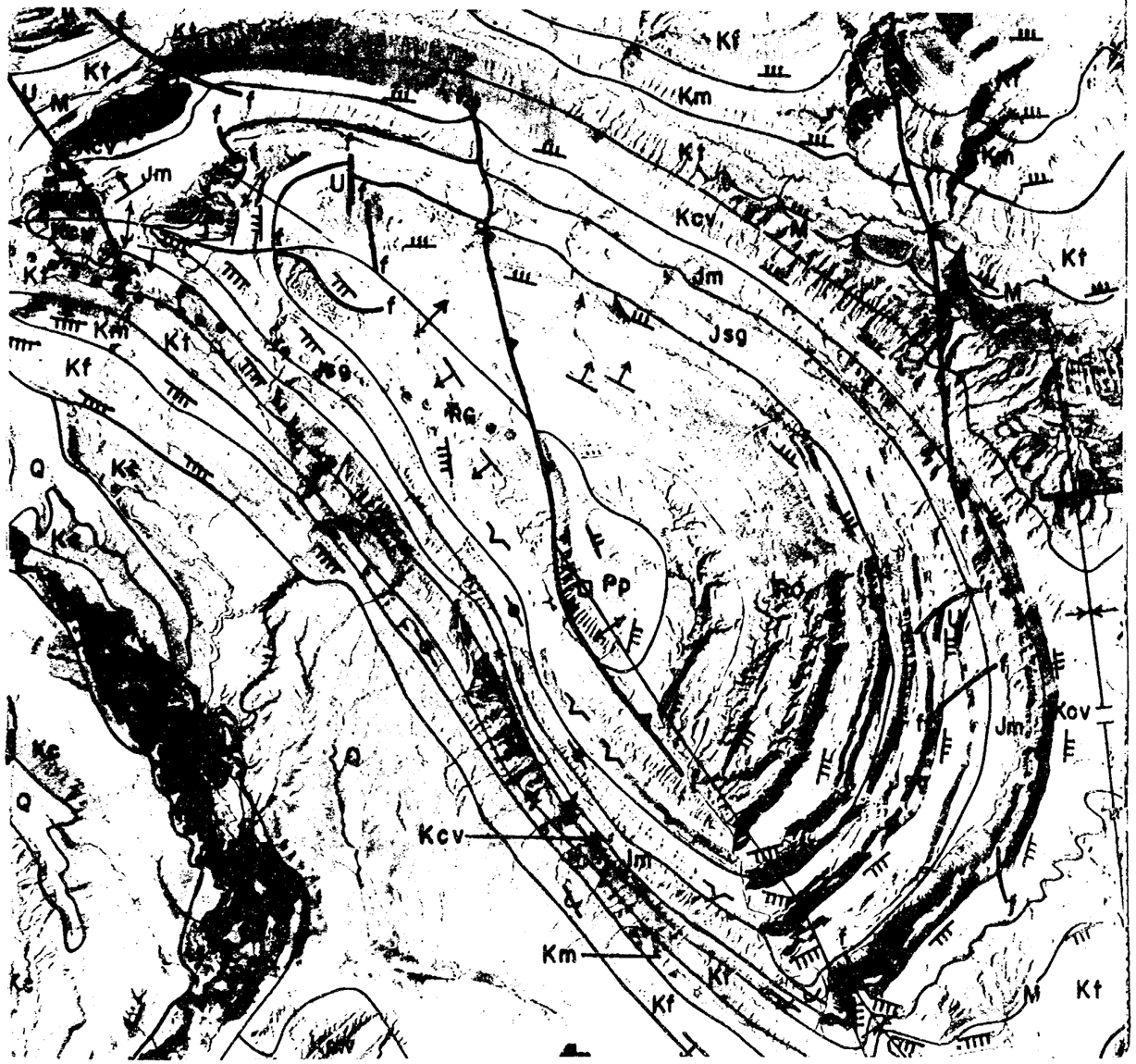
A geologic evaluation is necessary for the location of many engineering projects such as dams, air fields and highways. Detailed geologic maps prepared by IREX provide essential data on rock type and rock structure. By this means it is possible to select favorable sites which can be investigated on the ground, as required.

PETROLEUM GEOLOGY

Stereoscopic examination of air photographs provides the geologist with a bird's eye view of the earth's surface. Geologic characteristics indicative of oil and gas fields may often be deduced.

In these areas of potential petroleum accumulation detailed geologic mapping is essential. Preliminary study of the surface geology indicates areas where further exploration is advisable. Precise mapping of the selected areas can be accomplished through field surveys or photogrammetric means.

In many areas the rocks are poorly exposed at the surface and conventional surface geologic mapping is of little value. In such cases the stream patterns and landforms of the area are studied on the air photographs to provide clues to petroleum structures.

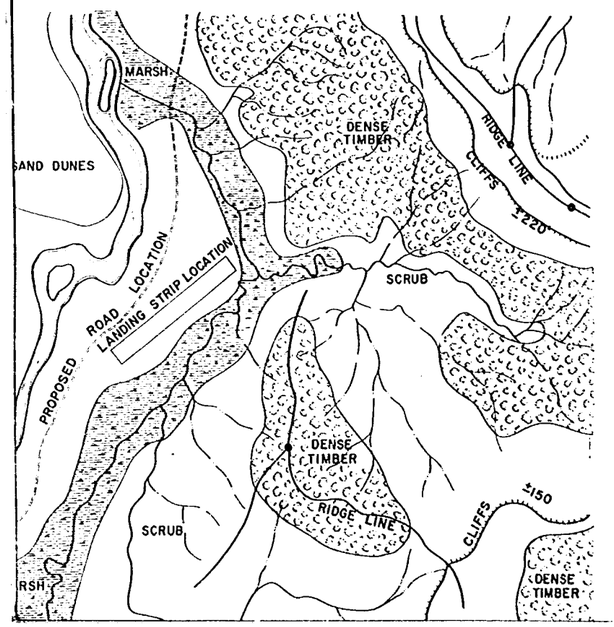


MINERAL DEPOSITS

Photogeologic and photographic requirements for mining evaluation are highly specialized. IREX, with its completely integrated services, is uniquely qualified to undertake such work. In some cases, color photography is employed to show important information not visible in black and white.

METALLIC RESOURCES

Many areas of potential mineral deposits can be detected through photogeologic evaluation. Intrusions, faults, joint systems and alteration zones—features often overlooked by ground reconnaissance—may be observed and evaluated by expert IREX photogeologists. This area is now a producer of tungsten.



NON-METALLIC RESOURCES

Limestone is required in iron smelting. Clay is used for bricks and industrial porcelain. Gravel is needed in road construction. Glacial till forms impervious cores for reservoir dams. Coal provides fuel and is a basic material for numerous synthetic products.

These and many other non-metallic resources are important for the development of industry. IREX photogeologic evaluation can assist in the rapid location of required materials. A complete geologic study and report form the desired foundation for subsequent surveys on removal, transportation and processing.

TERRAIN ANALYSIS

Terrain analysis is the interpretation of topographic characteristics—the basis for planning production and use of natural resources. It relates the isolated facts of terrain formation to human activity—mining, industrial, commercial, residential, recreational, or military.

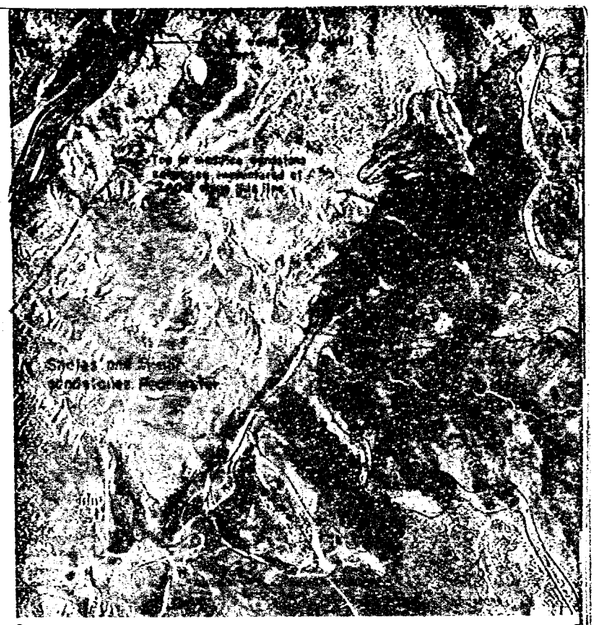
HYDROLOGY

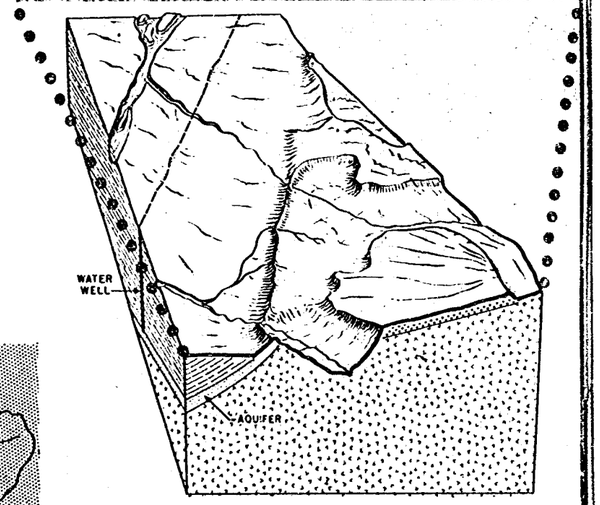
Water—essential to human life—necessary for agriculture—a prime source for electric power—a useful servant but one which must be controlled—requires the best scientific analysis for its utilization.

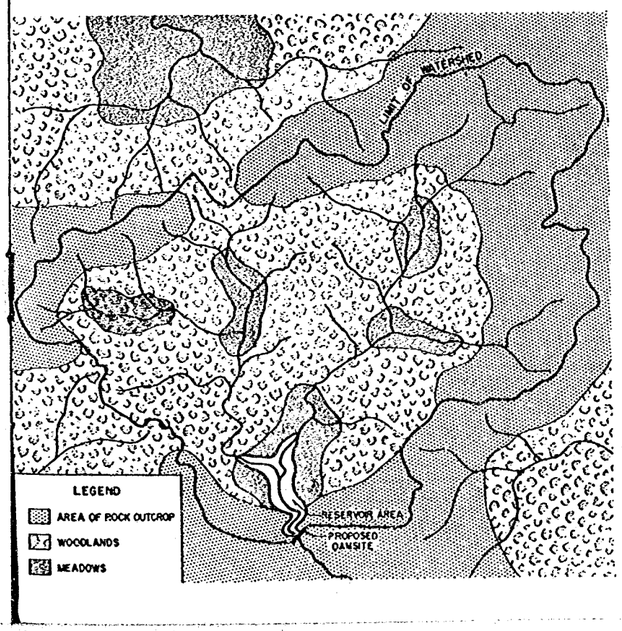
Problems of water supply and control confront the development of every area. In many instances success or failure hinges on this one resource. The significance of water is well known, but the need for its study is often overlooked in resources programs.

SUB-SURFACE WATER

Exploration for underground water supplies is facilitated by means of photogeologic evaluation. Favorable areas are selected and studied in more detail from air photographs and topographic maps. These studies indicate the best sites for well locations and are carried on more rapidly at less cost than by conventional ground studies.







SURFACE WATER

Air photography permits the rapid definition of drainage basins. Through this medium the character of the forest and soil cover is easily determined. This information combined with study of geology and rainfall statistics enable the specialist to make a fast, accurate analysis of the surface runoff. Air photography used in this manner obviates the need for time-consuming ground inspections and surveys. Further detailed study, permitted through the use of reconnaissance photographs, locates suitable reservoir areas.

The preparation of maps showing location and boundaries of commercially valuable timber reserves, or for soil classification, is often impractical on the ground. The oblique air photo shown above illustrates this problem.

IREX photo-interpreters working from vertical air photos at suitable scales can accurately and rapidly inventory forests and soils leading to the commercial development of these lands. Illustrations of the methods employed follow.

SOILS

Soils studies from air photos, as shown, are performed by skilled IREX interpreters:

A — Soils best suited for grazing; not suitable for agricultural crops.
B — Soils suitable for growing certain dry-land crops, such as grapes.
C — Soils best suited for timber production. With irrigation, would also produce apples, pears and other orchard crops.

In agricultural areas, trained personnel combine photo-interpretation with ground observation in developing soil improvement plans.

In this photo:

A — Soils in need of stabilization to control erosion.
B — Soils in need of chemical fertilizers and crop rotation to overcome their impoverished condition.
C — Soils that should have their highly irregular field boundaries revised to facilitate cultivation.
D — Soils already under control since contour farming has stabilized them, and crop rotation has improved their fertility.

Much of the barren soil in the top third of this photo would be highly productive if placed under irrigation.

FORESTRY

The photographs shown represent two typical photo-forestry studies, by IREX specialists.

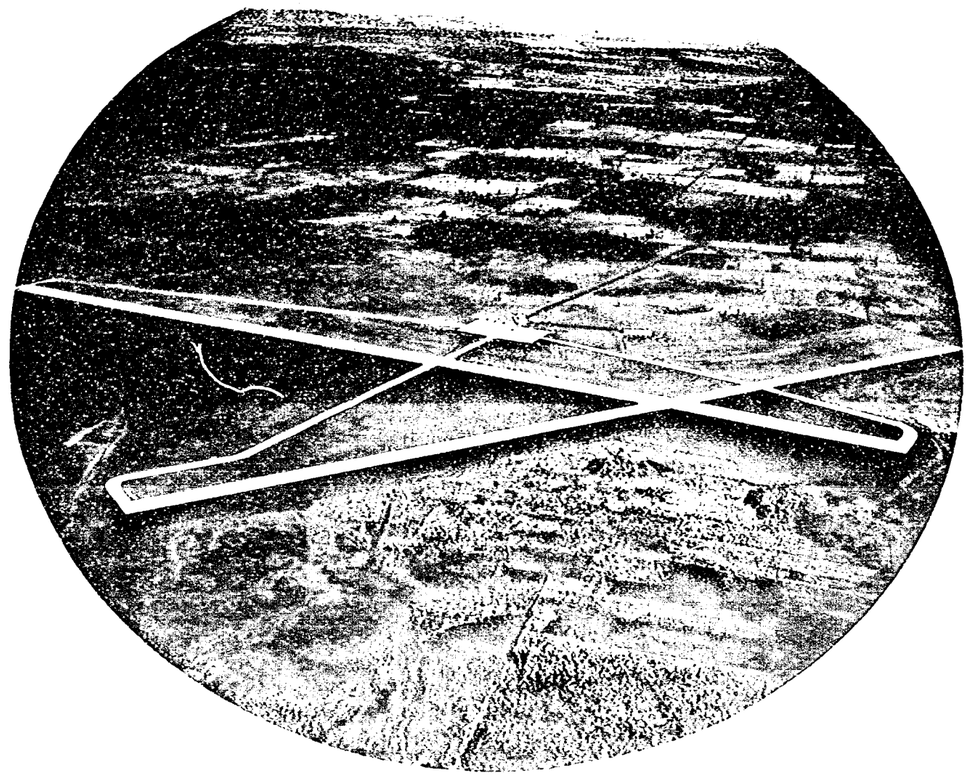
A — Commercially valuable conifers (softwoods) of merchantable size in mixture with young growth hardwoods.
B — Young growth hardwood trees which have not yet reached merchantable size.
C — Annual grasses well suited for livestock production.

A — Perennial grasses in a poorly drained meadow. Suitable for grazing only during dry season.
B — Coniferous (softwood) trees of a species which is not of sufficient commercial value to justify cost of logging.
C — Pure stand of commercially valuable conifers of loggable size.
D — Commercially valuable conifers. The trees are mature but small. Because of poorness of the site, this area would yield relatively low grades of lumber.
E — Dense brushfield, of value mainly as a source of cover and food for game animals.

ENGINEERING

Through the medium of air photographs and skilled photographic interpretation, valuable information is placed in the hands of trained IREX engineers. Supplemented by specific data as may be required, a wide variety of engineering projects may be rapidly, accurately and economically developed. Route selections for highways, railroads, pipelines or power transmission lines are made; dams, airfields, military bases or port installations are located; designs are made for drainage, irrigation and water supply. City and regional planning is also best served by this process.

This relatively new kind of engineering permits the handling of any or all phases of development, from preliminary planning through detailed engineering design.



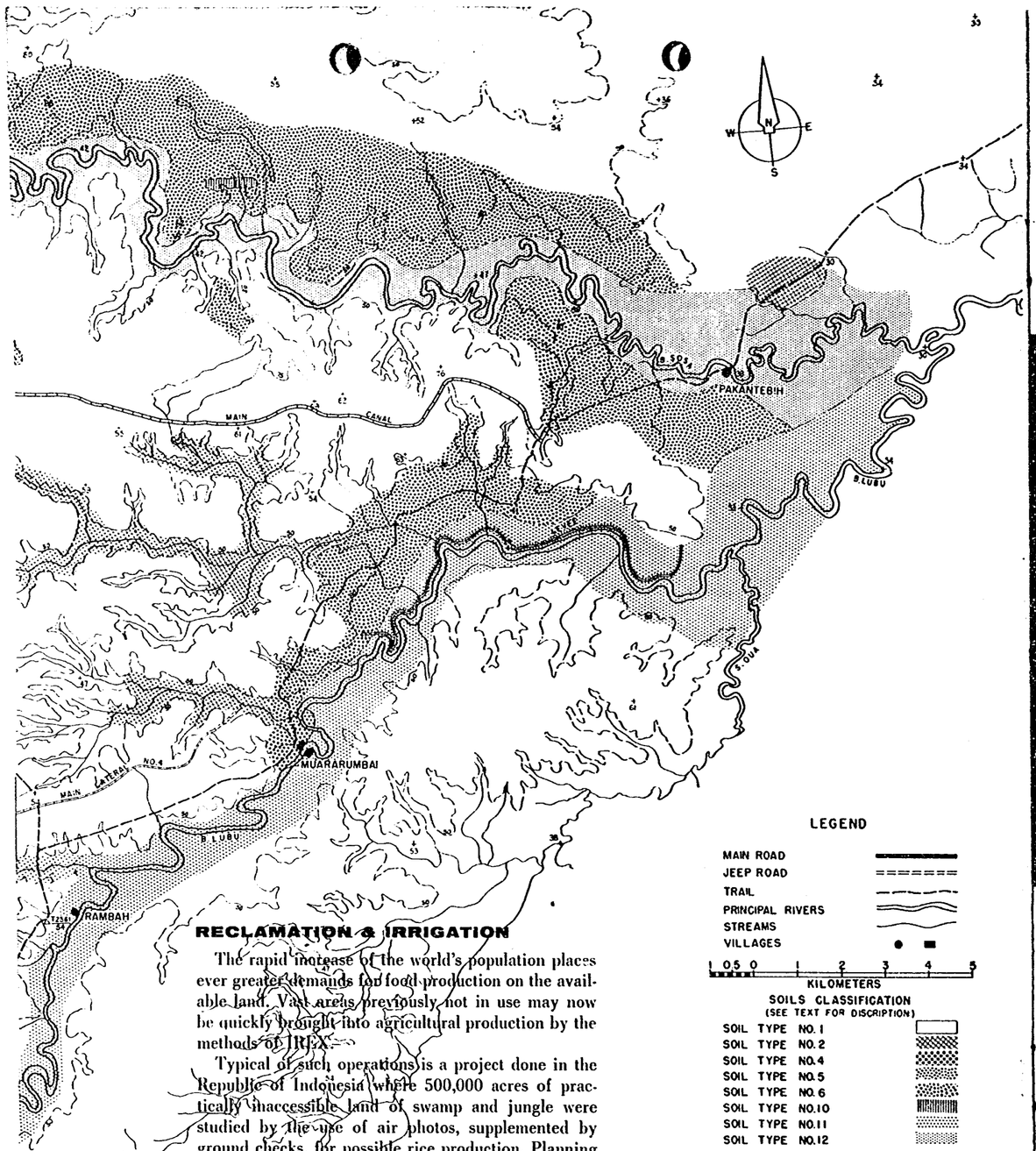
AIRFIELDS

IREX techniques are geared to the expeditious solution of airfield needs, from landing strips to municipal airports. Site selection, orientation, analysis of soil bearing properties, drainage, choice of building materials on a structural and economic basis, design of buildings and appurtenances are carried out by experienced engineer planners.

SITE SELECTION AND PLANNING

Sites for the vast industrial, commercial, residential and recreational complexes usually essential to the development and production of the earth's wealth are located and plans developed on the basis of modern air photo-analysis. Again, speed, accuracy and economy characterize this technique.

IREX Group engineers performed the site engineering for these two new industrial cities recently built in the jungles of Venezuela to support the development of United Steel Corporation's Cerro Bolivar ore deposits.



AGRICULTURAL DEVELOPMENT STUDY
SUMATRA – INDONESIA

SOILS MAP
PASIR PENGARAJAN AREA

RECLAMATION & IRRIGATION

The rapid increase of the world's population places ever greater demands for food production on the available land. Vast areas previously not in use may now be quickly brought into agricultural production by the methods of IREX.

Typical of such operations is a project done in the Republic of Indonesia where 500,000 acres of practically inaccessible land of swamp and jungle were studied by the use of air photos, supplemented by ground checks, for possible rice production. Planning of drainage, irrigation and grading was easily accomplised by these methods in record time.

This single project is potentially capable of converting the Republic of Indonesia from a rice importing country to a rice exporting country, with an obvious improvement in this country's economy and standard of living.

DAMSITES

The selection of damsites for the maximum development of water resources is accomplished by the use of air photography and geologic photo-interpretation. Areas of construction materials are located. Features influencing location of spillways, tunnels and canals are easily determined. Relocation of existing facilities may also be made so that detailed design is permitted with a minimum of time-consuming field work.

HARBORS

It is often desirable to carry out processing at great distances from the source of raw materials. A vital link in the chain is the harbor from which transshipment must take place.

Air photographs in the hands of skilled engineers are the basis for site selection and evaluation of construction potential. Subsequently, the design of the harbors and their related facilities—rail yards, warehouses, roads, pipe lines, conveyor belts—is performed in accordance with data obtained from larger scale photographs supplemented by a minimum of ground survey.

HIGHWAYS & RAILWAYS

Highways and railways—vital to the development of a nation's resources—are located, and line and profiles established quickly and economically through the use of air photography. Not only surface topography but geologic structure—essential in the design and estimating of foundations and tunnels—may be accurately determined through photographic interpretation. Related drainage and construction material problems are solved with equal ease by this technique. This photo shows one of the more than 128 million dollars worth of highways designed by IREX Group engineers.

COMBINED LIST OF IREX CLIENTS

[redacted]

RESOURCE SCIENTISTS (Geology, Hydrology, Agriculture, Forestry)	48
ENGINEERS (Civil, Structural, Mechanical, Hydraulics, Electrical, Chemical, Petroleum, Mining)	93
CITY PLANNERS	8
PILOTS & PHOTOGRAPHERS	18
FIELD SURVEY PERSONNEL	37
PHOTOGRAMMETRISTS & CARTOGRAPHERS	78
DRAFTSMEN	65
TECHNICIANS	59
SUB-TOTAL	406
ADMINISTRATIVE & CLERICAL	46
TOTAL	452

FINANCIAL STATUS

IREX Group members have excellent credit relationships with the Chase National Bank, New York; The First National Bank, Denver, Colorado; and The Alamo National Bank, San Antonio, Texas which enable them to undertake any project of which IREX is physically capable.

GOVERNMENT AGENCIES

Government of Indonesia
National Petroleum Council of Brazil
United States Government
- Aeronautical Chart and Information Service
- Army Corps of Engineers
- Army Map Service
- Atomic Energy Commission
- Bureau of Reclamation
- Commodity Stabilization Service
- Foreign Operations Administration
- Forest Service
- Geological Survey
- Soil Conservation Service

CITIES

Denver, Colorado
Kansas City, Kansas
Keokuk, Iowa
Dallas, Texas
Fort Worth, Texas
Houston, Texas
Palestine, Texas
Snyder, Texas
Poughkeepsie, N. Y.
New York, N. Y.

STATE HIGHWAY DEPARTMENTS

Arkansas
California
Colorado
Connecticut
Delaware
Kansas
Louisiana
Massachusetts
Mississippi
Nevada
New Jersey
New York
Ohio
Oregon
Rhode Island
Texas
Vermont
Washington
Wyoming

PUBLIC AUTHORITIES

Indiana Toll Road Commission
Kansas Turnpike Authority
Massachusetts Turnpike Authority
New Jersey Highway Authority
Jones Beach State Parkway Authority
New York State Thruway Authority
Triborough Bridge & Tunnel Authority
Ohio Turnpike Commission
Texas Turnpike Authority
West Virginia Turnpike Commission

PARKS

Long Island State Park Commission
Taconic State Park Commission
New York City Department of Parks

RAILROADS

Gulf Colorado & Santa Fe
Kansas City Southern
Southern Pacific
Union Pacific

GAS AND GAS TRANSMISSION

El Paso Natural Gas
Transcontinental Oil Corp.
United Gas Pipeline

MINING

Bear Creek Mining Co.
Columbia Geneve Steel Division
Day Mines
Orinoco Mining Co.

PETROLEUM

Amerada Petroleum Corp.
Argo Oil Corp.
Atlantic Refining Co.
British American Oil Prod. Co.
The California Co.
The Carter Oil Co.
The Chicago Corp.
Conorada Petroleum Corp.
Cities Service Oil Co.
Cuban American Oil Co.
Ganso Azul Oil Co.
Gulf Oil Corp.
Honolulu Oil Corp.
Houston Oil Co. of Texas
Humble Oil & Refining Co.
Lion Oil Co.
Magnolia Petroleum Corp.
Murphy Corp.
Ohio Oil Co.
Phillips Petroleum Co.
Pure Oil Co.
Richfield Oil Corp.
Richmond Petroleum Co.
Seaboard Oil Co.
Shell Oil Co., Inc.
Sinclair Oil & Gas Co.
Skelly Oil Co.
Socony-Vacuum Oil Co., Inc.
Sohio Petroleum Co.
Standard Oil Co. of California
Standard Oil Co. of Texas
Stanolind Oil & Gas Co.
Sun Oil Co.
Sunray Oil Corp.
The Superior Oil Co.
The Texas Co.
Tide Water Associated Oil Co.
Union Oil Co. of California

POWER AND LIGHT

Dallas Power & Light Co.
Dayton Power & Light Co.
Duke Power Co.
Idaho Power Co.
Indianapolis Power & Light Co.
Long Island Lighting Co.
Lower Colorado River Authority
Niagara Mohawk Power Co.
San Antonio Public Service
Texas Electric Service
Texas Power & Light Co.

LOCATION OF PROJECTS

Alaska
Australia
Brazil
British Somaliland
Canada
Colombia
Cuba
Egypt
Ethiopia
Guatemala
Indonesia
Kuwait
Neutral Territory—Arabia
Libya
Peru
Venezuela
U.S.A.— 45 states

IREX

INTERNATIONAL
RESOURCES ENGINEERING
AND EXPLORATION GROUP

NEW YORK, N. Y. DENVER, COLORADO SAN ANTONIO, TEXAS

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