AER Core Research Centre

List of Test Types Approved for Material Sampling

October 2014

Test	Includes	Description	Sampling category	Sample allowance	Residual material to be returned	Destructive/ contaminated
Absolute permeability		A measurement of the capacity for flow of a single fluid (water, gas, or oil) through a rock formation when the formation is completely saturated with that fluid.	REPS	1″–1.5″ drill plugs.	Yes	No
Acid compatibility	• **acid sensitivity** • **acid solubility** • **acid stimulation**	Testing to determine appropriate acid use in a reservoir with the intention of improving production by enhanced recovery techniques.	GOS	1″–1.5″ drill plugs.	No	Destructive
Acoustic velocity		Ultrasonic waves are passed through core sample to determine compression and shear wave velocity to calibrate sonic logs.	GOS	1″–1.5″ plugs or full diameter.	Yes	No

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Angle neutron scattering	• **Qem scan analysis** • **small/ultra/quasi angle neutron scattering (referred to as SANS, USANS, QENS)**	Technique used to investigate the structure, connectivity, and other physical-chemical properties for the pore network in porous media using a neutron beam. Data outputs for these studies include quantitative bulk mineralogical abundance data, mean mineral size, grain density, lithotype variation between samples, Macro Porosity estimations, and porosity distribution data	REPS	1″–1.5″ drill plugs.	Yes	No
Capillary pressure measurements	• **capillary pressure** • **capillary pressure by porous plate** • **capillary pressure by automated ultra-centrifuge** • **capillary pressure using air-mercury** • **capillary pressure using air-water** • **mercury injection capillary pressure (MICP)** • **mercury injection porosimetry study** • **mercury porosimetry** • **pore size distribution**	Mercury injection porosimetry data are used to determine pore size distributions of core samples. Cap pressure is used to calculate fluid distributions in a reservoir. Includes mercury injection (MICP), centrifugal (heated high speed), porous plate (at confining pressure) etc.	REPS	1 cubic inch for MICP. 1″–1.5″ drill plugs for porous plate or ultracentrifuge analysis.	No for MICP analysis Yes for porous plate or ultracentrifuge methods	MICP contaminated
Carbon isotope chemistry	• **bulk carbon isotopes** • **carbon isotope chemistry** • **isotope analysis**	Ratio of carbon isotopes found in tested material. Includes isotope geochemistry etc.	GOS	1 cubic inch.	No	Destructive

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Chromatography	• **aromatic/saturate GC-MS biomarkers** • **gas chromatography** • **gas composition** • **GC histogram** • **liquid chromatography** • **B10 mass chromatograms** • **thermal extraction chromatography** • **whole oil GC**	Analytical chromatography is used to determine the identity and concentration of molecules in a mixture	GOS	1 cubic inch.	No	Yes
CO_2 injection	• **C02 EOR study** • **C02 flow study**	An enhanced oil recovery method in which carbon dioxide (CO_2) is injected into a reservoir to increase production by reducing oil viscosity and providing miscible or partially miscible displacement of the oil.	REPS	1″–1.5″ drill plugs.	No	Destructive
Coalbed methane	• **ash analysis** • **coal chemistry** • **coal seams analysis** • **density versus ash** • **gas in place** • **moisture analysis** • **proximate analysis** • **ultimate analysis (coalbed methane)**	Laboratory tests conducted to evaluate these resources. Properties measured are on actual reservoir samples, either core or drill cuttings, with the most common analysis being proximate, ultimate, vitrinite reflectance.	REPS	Core: 2 cubic inches. Drill cuttings: Cover bottom of vial with random sample.	No	Destructive
Computed tomography (CT) scan	• **tomographic spectral imaging** • **CT scan**	Generates a 3D image that assists in showing the internal detail of a core, plug, or sample of material. It can show the contrast in mineralogy and density.	GOS	Whole or slabbed core, full diameter or small plug samples.	Yes	No

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Core flood	• **C02 core flood** • **alkali surfactant polymer flood** • **alkaline polymer flood** • **chemical core flood** • **core flood** • **enhanced oil recovery (EOR)** • **gas flood** • **gas flood susceptibility** • **immiscible floods** • **improved oil recovery (IOR)** • **linear core flood** • **miscible floods** • **polymer flooding** • **radial core flood** • **solvent flood** • **stacked core flow test** • **steam flood** • **thermal floods** • **water flood** • **water flood susceptibility**	Assists with determining enhanced oil recovery by pumping fluids, gas, or steam into wells to mobilize oil left behind during primary recovery. Types include chemical, H2O, steam, surfactants, polymers, solvent, radial, linear, etc.	REPS	1″–1.5″ drill plugs; may also use full diameter wafers about the size of a hockey puck.	No	Contaminated

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Core gamma	• **bulk density index** • **density neutron log** • **gamma-ray log** • **spectral gamma** • **B15Total gamma**	Core Gamma measures the natural radioactivity of the core, which comes essentially from the radioactive elements of the thorium series, Uranium-Radium series, and from the radioactive isotope K40 of Potassium. Total and Spectral core gamma helps define lost core and depth correction of core with downhole logs. The log can be of the total gamma ray response in API units, in elemental contributions of thorium (ppm), uranium (ppm), and potassium (%) and calibrated bulk density values (kg/m3).	GOS	Continuous sections of core greater than 1 metre in length. Can be slabbed residual core or whole core.	yes	no
Drilling mud leak-off		Evaluation of drilling fluid systems for horizontal and vertical applications in order to counteract fluid loss and wall collapse and to determine the appropriate use of drilling fluids.	REPS	1 cubic inch or 1.5″ drill plugs.	No	Destructive
Effective permeability	• **brine permeability** • **effective permeability to air** • **effective permeability to gas** • **effective permeability to oil** • **effective permeability to water**	The ability to preferentially flow or transmit a particular fluid when other immiscible fluids are present in the reservoir (e.g., effective permeability of gas in a gas-water reservoir).	REPS	1″–1.5″ drill plugs.	Yes	No

Test	Includes	Description	Sampling category	Sample allowance	Residual material to be returned	Destructive/ contaminated
Effective porosity	• **stressed brine porosity**	Measurement of pore volume that contributes to fluid flow or permeability. Excludes isolated pores and pore volume occupied by water adsorbed on clay minerals or other grains.	REPS	1″–1.5″ drill plugs or 2 cubic inches.	Yes if drill plugs	No
Electrical properties	• **anion exchange capacity** • **cation exchange capacity (CEC)** • **excess conductivity** • **formation factor** • **formation resistivity factor (FRF)** • **porosity exponent "m"** • **resistance factor ratio** • **resistivity index (saturation exponent)** • **saturation exponent "n"** • **formation resistivity index (FRI) saturation**	Through application of basic electrical relationships, formation resistivity parameters are obtained: porosity exponent "m," and saturation exponent "n."	REPS	1″–1.5″ drill plugs.	Yes	No
Fluid inclusion stratigraphy	• **FIT analysis**	Analysis of entrained organic and inorganic volatiles in fluid inclusions via quadrupole mass spectrometer (QMS).	GOS	Core: 1 cubic inch. Drill cuttings: Cover bottom of vial with random sampling.	No	Yes

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Fluid saturation	• **bitumen content** • **bulk mass fraction** • **connate water saturation** • **dean stark analysis** • **gas saturation** • **initial water saturation** • **liquid saturation** • **oil saturation** • **residual gas content** • **residual gas saturation** • **residual oil saturation** • **residual water saturation** • **tritium tracer invasion analysis** • **tritium tracer invasion analysis** • **water saturation**	Measurement of fluid saturation in a core sample by distillation extraction, retort analysis, etc. Includes dean stark, retort analysis (summation of fluids), saturation of water (SW) etc.	REPS	1″–1.5″ drill plugs or 80 g.	Dean stark method: - No if oil sands core - Yes if conventional core Retort analysis - No	No

Test	Includes	Description	Sampling category	Sample allowance	Residual material to be returned	Destructive/ contaminated
Fluids analysis	• **American Petroleum Institute gravity (API)** • **asphaltene precipitation** • **B43 fluid properties** • **bitumen isoreflectance** • **brine composition** • **bubble point pressure** • **chloride content** • **critical salinity** • **crude oil analysis** • **density of gas** • **density of oil** • **dynamic pore-flow** • **effluent analysis** • **fluid characterization** • **fluid evaluation** • **fluid study** • **gas compressibility** • **gas deviation factor** • **gas viscosity** • **kinematic viscosity** • **liquid hydrocarbon analysis** • **methylene blue index** • **nickel and vanadium** • **nickel content** • **oil compositional analysis** • **oil compressibility** • **oil density** • **oil viscosity** • **organic solvent extraction** • **polymer rheology** • **relative density** • **relative viscosity**	The acquisition and testing of reservoir fluids to determine the fluid composition, fluid physical properties, and chemistry. It is used in a variety of applications for hydrocarbon recovery models.	GOS	Core: Fluids/gases are typically extracted from core samples or captured at the well site.	No	Fluids not stored at the CRC

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Fluids Analysis continued	• **reservoir fluid analysis** • **reservoir fluid composition** • **reservoir fluid study** • **routine analysis** • **routine gas analysis** • **routine water analysis** • **SARA (saturates, aromatics, resins and asphaltene) composition** • **solids content in oil** • **soluble ions** • **solution & liberated gas-oil ratio** • **solution gas and oil ratio** • **specific gravity** • **sulphur content** • **sulphur content in oil** • **trace sulphur analysis** • **vanadium content** • **viscosity** • **water analysis** • **water compositional analysis** • **water content in oil**		GOS	Core: Fluids/gases are typically extracted from core samples or captured at the well site.		
Formation damage	• **compatibility study** • **critical velocities** • **fines migration** • **fluid sensitivity** • **velocity sensitivity test**	Analysis to assist in determining damage to a formation due to drilling muds and water, which in turn affects porosity and permeability measurements of the reservoir. Includes fluid sensitivity, fine migration, fluid compatibility, liquid permeability recovery, etc.	REPS	1″–1.5″ drill plugs.	No	Destructive

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Fracture analysis	• **fracture conductivity** • **paleomagnetic fracture analysis**	Used to determine reservoir fracture characteristics that exist during reservoir modelling, designing well drainage patterns and well completion/stimulation programs.	GOS	1″–1.5″ drill plugs.	No	Destructive
Geochemistry	• **geochemistry** • **kerogen facies assemblage** • **kerogen microscopy** • **pyrolysis** • **stable isotope analysis**	A combination of a number of analysis types to define the richness, type (oil/gas), and thermal maturity of organic matter in geological material or potential source rock. Includes rock eval/pyrolysis, TOC, vitrinite reflectance and kerogen microscopy, etc.	GOS	Core: 1 cubic inch.Drill cuttings: Cover bottom of vial with random sample.	No	Destructive

Test	Includes	Description	Sampling category	Sample allowance	Residual material to be returned	Destructive/ contaminated
Geomechanics properties	• **Brazil tension** • **Brinell hardness** • **brittleness analysis** • **compressibility of reservoir rock** • **direct shear test** • **dynamic elastic properties** • **failure parameter** • **fracture azimuth** • **fracture toughness** • **geomechanics** • **indentation hardness test** • **Mohr-Coulomb failure analysis** • **Poisson's ratio** • **rock mechanics** • **scratch test/tsi** • **shear modulus axial** • **shear modulus transverse** • **shear rate test** • **static elastic properties** • **triaxial** • **triaxial compressive test** • **triaxial shear modules** • **triaxial strength** • **ultrasonic velocity** • **unconfined compression** • **uniaxial analysis** • **Young's modulus**	Geomechanics is the subject/analysis concerned with the response of a rock/sample to applied disturbances. It includes the property of the sample's ability to resist deformation, its change in hydrostatic pressure in correspondence to volumetric strain, the ultimate strength of a rock, etc. The mechanical properties of the subsurface formations is important in connection with wellbore stability problems, fracturing operations, subsidence problems and sand production problems. Includes mono/uni/triaxial, sonic/ultrasonic velocity, static/elastic properties, Young's modulus, Poisson's ratio, brazil tensile strength, Brinell hardness, etc.	REPS	Full diameter core to 20 cm or 1″–1.5″ drill plugs.	Yes for full diameter. No for small plugs.	Destructive (return residue from full diameter)
Grain density		Calculated from the measured dry weight divided by the grain volume of a core sample.	REPS	1″–1.5″ drill plugs or 1 cubic inch. Can also be performed on full diameter sample during routine analysis.	Yes if drill plugs or full diameter.	No

Test	Includes	Description	Sampling category	Sample allowance	Residual material to be returned	Destructive/ contaminated
Interfacial tension (IFT)	• **liquid–liquid interfacial tension** • **liquid–rock interfacial tension**	Analysis method to measure the surface and interfacial tension of liquids to other liquids or to rock.	GOS	Core: 1 cubic inch.	Yes	No
Leak-off Analysis	• **drilling mud leak-off** • **dynamic frac fluid leak-off** • **dynamic leak-off test** • **leak-off tests** • **pressure integrity**	A test to ascertain the ability of a drilling fluid to seal permeable rock under down hole conditions to monitor and mitigate fluid invasion trends on reservoir rocks.	REPS	1″–1.5″ drill plugs.	Yes	No
Mass spectrometry	• **coupled plasma spectrometry** • **inductivity coupled plasma spectrometry**	This is a type of mass spectrometry that is capable of detecting metals and several non-metals at concentrations as low as one part in 10^{12} (part per trillion). This is achieved by ionizing the sample with inductively coupled plasma and then using a mass spectrometer to separate and quantify those ions.	GOS	Core: 1 cubic inch.Drill cuttings: Cover bottom of vial with random sampling.	No	Yes
Microbial enhanced oil recovery (MEOR)		A technology/study using the biological activity of the microorganisms to enhance oil recovery through mobility characteristics of the oil.	REPS	1″–1.5″ plugs or full diameter.	Yes	No

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Nuclear magnetic resonance (NMR)	• **nuclear magnetic resonance spectroscopy**	Measurement of NMR properties in a formation to assist in the detection of formation hydrogen. Used to find total porosity and bound and free fluids within pore spaces of analyzed samples and to calibrate downhole NMR logs. This is a research technique that exploits the magnetic properties of certain atomic nuclei. It determines the physical and chemical properties of atoms or the molecules in which they are contained. It relies on the phenomenon of nuclear magnetic resonance and can provide detailed information about the structure, dynamics, reaction state, and chemical environment of molecules.	REPS	1″–1.5″ plugs or full diameter.	Yes	No
Particle size analysis (PSA)	• **Coulter analysis** • **laser particle size analysis (LPSA)** • **particle size distribution analysis** • **sieve analysis**	Particle size is a notion introduced for comparing dimensions of solid particles. Particle size analysis will show distributions of particle sizes within a sample (or combined sampled zone). Includes particle size distribution (PSD), laser particle size analysis (LPSA) Coulter analysis, sieve analysis, etc.	GOS	LPSA: >5 g Sieve: >25 g	No	No

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Permeability	• **air permeability** • **CMS 300 analysis** • **in situ permeability** • **Klinkenberg permeability study** • **liquid permeability** • **max permeability** • **micro permeameter** • **permeability measured vertically** • **permeability measured at 90 degrees** • **permeability plugging test** • **pressure decay profile permeametry** • **pulse decay permeability (PDP)** • **reservoir condition unsteady-state** • **specific permeability to brine** • **vertical permeability**	The measurement of the ability to transmit a fluid or gas through a rock formation.	REPS	1″–1.5″ drill plugs or full diameter samples may be used.	Yes	No

Test	Includes	Description	Sampling category	Sample allowance	Residual material to be returned	Destructive/ contaminated
Petrology/mineralogy	• **biodegradation** • **bioturbation** • **geological report** • **lithofacies** • **lithology** • **maceral analysis** • **micropaleontology** • **mineral identification** • **mineralogy** • **organic petrology** • **paleontology** • **palynological analysis** • **palynology** • **petrographic studies** • **petrography** • **stratigraphy** • **thin section petrographics** • **thin section photomicrography**	Means of evaluating the mineralogy and pore system of reservoir rock samples. Also includes the study of macroscopic features of rocks, such as their occurrence, origin and history, structure, texture and composition. Includes petrography, palynology, organic petrology, etc. The finished thin section slide is viewed under a microscope to examine by point counting or image analysis the mineralogy, texture, diagenesis, pore system, reservoir quality, and macroscopic features of the sample.	GOS	Core: Thin section can be produced from 1 cubic inch but occasionally geologists will request a piece up to 3 times the size to produce a larger thin section or multiple thin sections. Drill cuttings: Cover bottom of vial with random sample.	No	Destructive

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Photography and Imaging	• **conodont photographs** • **diffuse reflectance infrared** • **digital imaging** • **electron microscopy (HRTEM)** • **fourier transform** • **high resolution transmission** • **hyperspectral core scanning** • **micro paleo photography** • **net pay analysis via digital imaging** • **Raman micro spectroscopy** • **scanning electron microscope** • **SEM photographs** • **spectroscopy (drifts)** • **thin section photographs** • **ultra violet core photography** • **v-shale analysis** • **white light core photography**	The image acquisition of physical scene such as a thin section or core/core sample.	GOS	As required.	Yes	No
Porosity	• **helium porosity** • **in situ porosity** • **pore volume fraction** • **summation of fluids porosity** • **total porosity unconfined porosity**	The percentage of pore volume or void space versus the bulk volume of the rock, or that volume within rock that can contain fluids or gas.	REPS	1″–1.5″ drill plugs or full diameter samples may be used.	Yes	No

Test	Includes	Description	Sampling category	Sample allowance	Residual material to be returned	Destructive/ contaminated
Pressure decay profile permeametry (PDPK)		Measures permeability promptly, accurately, and repeatably using a point pressure system at regular intervals as requested.	REPS	Flat surface of core (slabbed core).	Yes	No
Pressure volume temperature	• **mud-gas composition** • **oil formation volume factor** • **recombined separator sample** • **reservoir pressure & temperature formation volume factor** • **separator test**	The volumetric and phase behaviour analysis of produced hydrocarbons.	REPS	As required.	No	No
Proppant embedment analysis	• **proppant embedment**	Used to determine the proppant effectiveness of reservoir rock.	REPS	10″ X 1/2″ slab. Or small drill plugs	No	Destructive
Pyrolysis		Sample subjected to controlled heating in an inert gas to or past the point of generating hydrocarbons. Provides assessment as a source rock, quantity of organic material, thermal maturity, and quality of hydrocarbons.	GOS	Core: 1 cubic inch. Drill cuttings: Cover bottom of vial with random sampling.	No	Destructive
Regain permeability	• **fluid injection recovery** • **regain conductivity** • **regain permeability test** • **slick water regain conductivity**	A permeability measurement that ignores the influence of a reservoir fluid and strictly evaluates the test fluid-rock interaction. It provides a comparison between different proposed drilling/completion fluids and predicts what damage mechanisms may occur. Regain permeability is also often used for evaluating acid stimulation fluids.	REPS	1″–1.5″ drill plugs.	No	Contaminated

Test	Includes	Description	Sampling category	Sample allowance	Residual material to be returned	Destructive/ contaminated
Relative permeability	• **imbibition** • **relative permeability ratio gas to oil** • **relative permeability ratio water to oil** • **relative permeability to gas/oil/water**	Relative permeability is the ratio of effective permeability of a particular fluid at a particular saturation to absolute permeability of that fluid at total saturation.	REPS	1″–1.5″ drill plugs.	Yes	No
Rock thermal conductivity	• **caprock analysis** • **coefficient of linear thermal expansion** • **heat generation** • **specific heat thermal relaxation** • **thermal conductivity** • **thermal diffusivity** • **volumetric heat capacity**	Thermal conductivity is the property of a material to conduct heat.	GOS	1″–1.5″ drill plugs or full diameter to 20 cm.	Yes for full diameter (unless contaminated) No for small plugs	Destructive May be contaminated
Scanning electron microscope (SEM)	• **SEM stub**	Used to determine and identify the structure of substances and to identify individual clay minerals and their physical locations in the pore system. Ability to measure density differences that can highlight textures and micro-pores in very fine rocks such as shales and siltstones. This data coupled with the XRD data is evaluated to determine engineering precautions in order to avoid adverse effects on the reservoir during the drilling, completion, and production phases of reservoir development.	GOS	Core: 1 cubic inch.Drill cuttings: Cover bottom of vial with random sample.	yes	Destructive

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Shale analysis	• **GRI** • **shale gas analysis** • **shale rock properties** • **tight rock analysis**	Extensive testing of shale reservoirs, including porosity and permeability measurement, saturations from dean stark analysis or retort analysis, grain and bulk density measurements, etc.	REPS	8 to 20 cm of a bulk slab portion depending on the diameter of the core	yes if thermally unaltered	destructive
Shale stability tests	• **brine compatibility** • **brine sensitivity test** • **capillary suction time tests (CST)** • **ratio of Kro to Kair (effect of clay swelling)** • **roller oven tests (RO)** • **shale stability** • **stability test**	Analysis that investigates the chemical effects of the drilling fluid on the dispersive properties of shale and active clays.	GOS	Core: 1 cubic inch.	No	Yes
Sorption analysis	• **adsorption** • **adsorption isotherms** • **desorption** • **desorption analysis** • **gas in place** • **langmuir** • **longmuir** • **lost gas calculations** • **methane adsorption isotherm** • **static adsorption test**	Sorption isotherm (also adsorption isotherm) describes the equilibrium of the sorption of a material at a surface (more general at a surface boundary) at constant temperature. It represents the amount of material bound at the surface (the sorbate) as a function of the material present in the gas phase and/or in the solution.	REPS	Full diameter core to 20 cm.	Yes	No
Source rock analysis /rock evaluation	• **pyrolysis** • **rock evaluation** • **S1** • **S2** • **S3** • **source rock properties** • **T-Max** • **TOC** • **thermal maturity**	A combination of a number of analysis types to define the richness, type (oil/gas), and thermal maturity of organic matter in geological material/potential source rock. Includes rock eval/pyrolysis, TOC, vitrinite reflectance and kerogen microscopy, etc.	GOS	Core: 1 cubic inch. Drill Cuttings: cover bottom of vial with random sampling.	No	Destructive

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Thin section slides	• **thin section slides**	The laboratory preparation of a rock sample that is mounted on a glass slide and is thinly ground and polished to be viewed under a polarizing petrographic microscope.	GOS	1 cubic inch core/bottom of drill cutting vial	yes	no
Total organic carbon (TOC)	• **Leco TOC** • **TOC**	Amount of organic carbon (wt%) via chemical methods (e.g., Leco TOC) or heating (e.g., Rock Eval).	GOS	Core: 1 cubic inch. Drill cuttings: Cover bottom of vial with random sampling.	No	Destructive
Vitrinite analysis	• **vitrinite reflectance** • **VRO**	Measures thermal maturity of organic matter to determine whether hydrocarbons have been generated or could be an effective source rock.	GOS	Core: 1 cubic inch Drill cuttings: Cover bottom of vial with random sampling.	No	Destructive
Wettability	• **Amott wettability index** • **U.S. Bureau of Mines wettability index** • **Modified USBM wettability**	The tendency of one fluid to spread over the surface of a solid rather than another (wetting phase). An absorption test indicates the potential of water or oil to absorb into a rock. The wettability of the rock is determined by which fluid is more readily absorbed.	GOS	1″–1.5″ drill plugs or 2 cubic inches.	No	Destructive
X-ray diffraction	• **bulk x-ray diffraction** • **clay analysis** • **elemental mapping** • **x-ray diffraction** • **x-ray energy spectrometry**	Provides identification of minerals for petrographic correlations including rock composition and analysis of clay fraction. Can assist in understanding and evaluating well log data as well as stratigraphic and core logs.	GOS	Core: 1 cubic inch Drill cuttings: Cover bottom of vial with random sampling.	No	Destructive

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X-ray fluorescence (XRF)	• **chemostratigraphy** • **chemostrat analysis**	Through the emission of low energy (fluorescent radiation), this analysis can detect the bulk abundances of major and trace elements in a bulk sample (large fraction of geological material).	GOS	XRF scan is done on whole or slabbed core or larger geological samples (non-destructively).	Yes	No