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**Departmentof: Earth Science and Petroleum**

**College of: Science**

**University of: Salahaddin**

**Subject: Practical Geochemistry**

**Course Book: Year 4**

**Lecturer's name: Awaz Kareem Rasul( Ph.D.) and Mrs. Zhin Saeb (master)**

**Academic Year: 2022/2023**

**Course Book**

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| **1. Course name** | **Geochemistry** |
| **2. Lecturer in charge** | **Awaz K. Rasul (Ph.D.)** |
| **3. Department/ College** | **Department of Earth Science and Petroleum/ College Science** |
| **4. Contact** | **e-mail: awaz.rasul@su.edu.krd****Tel: 07504496509** |
| **5. Time (in hours) per week**  | **Practical: 8**  |
| **6. Office hours** | **2-3** |
| **7. Course code** |  |
| **8. Teacher's academic profile**  | \* Graduated at the Department of Geology, Salahaddin University/ Coll of Science (1991-1992). \* Worked as an assistant at the Salahaddin University/ College of Science (1993-1994)).\* M.Sc. student in geochemistry at Salahaddin University, (2002-2003). Thesis title “Geochemistry study of recent sediments of Greater Zab River, Kurdistan Region- NE Iraq”.\* Ph.D. student and Teaching at the Salahaddin University, (2012-2013). Thesis title “Hydrochemistry and Geochemistry of recent sediments of Lesser Zab River and Dokan Reservoir, Kurdistan Region-NE Iraq”.\* During my work I carried out five of published researches and scientific reports. \* From 1993 till now I gave many courses in the Department of Geology such as Rock-Forming Mineral, Crystallography, Geochemistry and theory of General Geology in Agriculture college. |
| **9. Keywords** | **Science, Geochemistry, elements, Minerals, hydrochemistry** |
| **10. Course overview:**  This course will cover the most important topics of Geochemistry, which focuses on the chemistry of the natural world and the chemical evolution of the Earth. We will discuss theoretical geochemistry, with an emphasis on how chemical principles are used to study Earth Sciences. The course is composed of two Terms: (a) Study the laws of thermodynamics and apply them to the natural chemical reactions and Characteristics of the elements (ions) in sediments and water about the mobility, and precipitate, and also study the chemical analysis for these elements for major cations and anions. The last laboratory deals with the geochemistry of the isotopes especially which become very important at the last years to apply it for the estimation of the age of the formation of the studied rocks and prediction of the climate during the deposition and in sometimes the salinity of the water under which the minerals are deposited. (b) the second term is Exploration Geochemistry which studies the kind and methods of survey and then includes field geology around Erbil with collecting the samples of clay, after that there’s laboratory work to prepare the samples for chemical analysis and finally they make Report and Writing these information:1- Introduction about the geochemical survey.2 drawing the map for the studying area.3- Field working & laboratory.4- Drawing the relationship between the concentrations for each element with the direction path.5- Find Correlation coefficient.6- Drawing the Histogram between the class interval and frequency.7- Drawing the S-shape between the cumulative frequency % on the Logarithm axes and the smallest value for each class interval on normal axes.8- Find Anomaly, Background and Threshold.9- Discussion &. Resulting.10- References  |
| **11. Course objective:** Regular attendance is the best way to assure a good grade in this class. A different form of teaching is illustrated to gain the best results, and It is much easier to absorb the information in a lecture than to try and learn it on your own from the text. As an incentive to come regularly, quizzes will be given every 2 or 3 lectures.  The students will be able to understand the geochemistry of the elements that are represented in the periodic table. Chemical characteristic and distribution of these elements in the lithosphere is the aim of understanding the element. The students will be interested in isotopes (radioactive and stable). The students would be employed in this subject in the estimation of the age of the formation of the studied rocks  |
| **12. Student's obligation** In this course, the students will be required for two monthly exams, the first in the middle of the course, and the second at the end of it. The student’s obligation during the course is attendance in class for three hours for studying the practical part and apply it in the laboratory. There are many tests in the labs. Students also will be required to a weekly report about the former laboratory they had taken, at final it will be graded by 2.5 marks.   |
| **13. Forms of teaching** Different forms of teaching will be used to reach the objectives of the course: a PowerPoint presentation will illustrate show the main points like titles and definitions and a summary of conclusions, a blackboard to clarify ideas, and office work by designing worksheets to solve and analyze geochemistry problems discussions and homework’s, all figures that related to the lectures. Furthermore, sometimes students will be asked to prepare research papers on selective topics, these topics need to be from printed media or the internet. There will be classroom discussions in the last ten minutes of the labs.  To get the best out of the course, it is suggested that you attend classes as much as possible, and read the required lectures before the time of the lecture, and the teacher's notes regularly as all of them are foundations for the course. Try as much as possible to participate in classroom discussions.  |
| **14. Assessment scheme**‌ The students are required to do one practical exam at the end of the semester. One semester has 15 marks, so we divided it like that: the attendance, classroom activities, and home works count with quizzes 1.0 marks and weekly report has 2.0 marks also, and the exam in the first term has 4.5 marks. There will be a final exam on 7.5 so the final grade will be upon the following criteria:  The course mark: is 7.5  Final exam:7.5 Therefore the total mark will be 15 |
| **15. Student learning outcome:** Some of the students after graduated they employed in water resources companies in the public and private sectors. In the last years, many oil companies come to Kurdistan Region for oil exploration and production, in wide areas along the region, so several geologists are followed these companies, and others work with the geological survey where the mineral resources are available in the region.  |
| **16. Course Reading List and References‌:** Required books:1) White, W.M. 2005, Geochemistry, John Hopkins University Press, 701p.2) Brownlow, A.H., 1979, Geochemistry, Prentice-Hall, Inc., New Jersey, 498p. 3) Krauskopf, K., 1967, Introduction to geochemistry, McGraw-Hill, Inc., New York, 721p. Students are encouraged to search for the Journals and the internet that may help them in this course, such as:1) Geochemica et Cosmochimica Acta*.*2) Chemical Geology3) Geochemical exploration |
| **17. The Topics:** | **Lecturer's name** |
| In this section, the lecturer shall write the titles of all topics he/she is going to give during the term. This also includes a brief description of the objectives of each topic, date and time of the lecture Each term should include not less than 16 weeks  |  |
| **18. Practical Topics (If there is any)** |  |
| Week (1): Introduction to thermodynamics (system, phase, components, thermal equilibrium).Week (2): Laws of thermodynamics. Entropy, Enthalpy, Gibbs Free energy, and curve of reaction.Week (3): Quiz for the lab. (1 and 2). The relative mobility of elements. Week (4): Calculation of Hypothetical salt combination from water analysis. Week (5): Calculation of Hadrochemical Evaluation of the waterWeek (6): Quiz for the labs. (4 and 5). Calculation of the insoluble residue (I.R %) by the practical method. Week (7): Calculation of Ca/Mg ratio in water by EDTA method.Week (8): Calculation of Ca/Mg ratio in carbonate rocks by EDTA method.Week (9): Calculate K & Na by using a Flame photometer.Week (10): Quiz for the labs. (7, 8, and 9). Radioactive Isotope Geochemistry (Rb-Sr system).Week (11): Radioactive Isotope Geochemistry (U-Pb), and Concordia curve.Week (12): Radioactive Isotope Geochemistry (K-Ar Isotope Dating). Week (13): Practical midterm exam for labs., (6, 7, 8, and 9).Week (14): Theoretical midterm exam.This syllabus may be subject to changes, i.e., we may take either longer or shorter time to finish topics, and if any changes happened you will be notified well in advance. | Dr. Awaz Kareem RasulMrs. Zhin SaebTime 2 hours  |
| 19. Examinations: Examples***Salahaddin University Geochemistry: practical*** ***College of Science 4th Class******Department of Geology Time: 90minutes******First Term- The academic year 2023*****Q1)** River has the following chemical parameters, if pH is 8.5 and the EC is 380µS/cm, find the following? **(30 Marks)**1. Calculate hypothetical salt, and which salt precipitate at the first?
2. Hadrochemical formula and type of water?
3. In which climate the river is rich with these ions, depending on the type of water?
4. The value of HCO3 return of the whole HCO3, or CO3, or both of them, and why?
5. Why are the cations in the river have high mobility, depend on solubility?

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| --- | --- | --- | --- |
| Ions | ppm | Ions | ppm |
| Ca | 22.3 | HCO3 | 100.1 |
| K | 25.5 | Cl | 78.3 |
| Na | 40.6 | NO3 | 3.1 |
| Mg | 10.78 | SO4 | 22.4 |

**Note:** Atomic weight for Ca= 40.08, Mg=24.32, Cl= 35.457, Na= 22.99, K= 39.1. Molecular weight for HCO3= 61, NO3= 62, SO4= 96.**Q2**) 1- Draw the curve for the reaction below, Is the reaction at an equilibrium state?  **(30Marks)** Kyanite ↔ Sillimanite  ∆H =+1770, ∆S= +2.95, ∆V =+0.13891. Which one is stable at high pressure but relatively low temperature?
2. Write the first law of thermodynamics.
3. If we have this reaction ( Quartz ↔ Glass ) and the ∆G > 0, the reaction proceeds to which direction?
4. Find K (equilibrium constant) when the phases are pure and ideal mixing.

**Good Luck**  Dr. Awaz K. Rasul Mrs. Zhin**Answer****Q1) 1- the first salt Ca(HCO3)2**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Ions | ppm | At.Wt. | charge | epm | Sum | epm% |
| Ca | 22.3 | 40.08 | 2 | 1.11 | 4.42 | 25.19 |
| Mg | 10.78 | 24.31 | 2 | 0.89 | 4.42 | 20.08 |
| Na | 40.6 | 22.99 | 1 | 1.77 | 4.42 | 39.97 |
| K | 25.5 | 39.1 | 1 | 0.65 | 4.42 | 14.76 |
|   | 99.18 |   |   | 4.42 |   | 100.00 |
| HC03 | 100.1 | 61.01 | 1 | 1.64 | 4.37 | 37.54 |
| S04 | 22.4 | 96.07 | 2 | 0.47 | 4.37 | 10.67 |
| Cl | 78.3 | 35.45 | 1 | 2.21 | 4.37 | 50.54 |
| N03 | 3.4 | 62.01 | 1 | 0.05 | 4.37 | 1.25 |
|   | 204.20 |   |   | 4.37 |   | 100.00 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Ions | epm% | **Hypothetical salt** | **Precipitate** | Remain |
| Ca | 25.19 | Ca(HCO3)2 | 25.19 | 12.35 |
| Mg | 20.08 | Mg(HCO3)2 | 12.35 | 7.73 |
| Na | 39.97 | MgSO4 | 7.73 | 2.94 |
| K | 14.76 | Na2SO4 | 2.94 | 37.03 |
|   | 100 | NaCl | 37.03 | 13.51 |
| HC03 | 37.54 | KCL | 13.51 | 1.25 |
| S04 | 10.67 | KNO3 | 1.25 | 0 |
| Cl | 50.54 |   |   |   |
| N03 | 1.25 |   |   |   |
|  | 100 |  |  |  |

**2- TDS= EC\*0.65****TDS= 380\*0.65= 247** **Cl(50.54) – HCO3(37.54) – SO4(10.67) –NO3(1.25)****TDS(247)= -------------------------------------------------------------------**  **Na(39.97) – Ca(25.19) - Mg(20.08) - K(14.76)****3-The value is HCO3 and CO3, because pH is 8.5 (basic)****4- the climate is dry because we have rich of Na+ and Cl-.**1. **They have low ionic potential.**
2. **Q2) 1- ∆G = ∆H - T ∆S + ∆V(P-1) at equilibrium state ∆G =0**

**At pressure constant (known)** T=∆H/ ∆S At temperature constant (known) P = ∆S/ ∆V  T=∆H/ ∆S = 1770/2.95= 600 - 273= 3270C at 1 bar (327, 1)  ∆S/ ∆V= 2.95/ 0.1389= 21.24 bar/degree  At known 100 temperature 327+100= 4270C  At 1000C the 21.24\*100= 2124 2- Kyanit3- dE=Q – W4- the reaction proceeds to left 1. K=1 because X=1, γ =1 and ai =Xi • γi for that activity (a)= 1

 an products K = ----------------- = 1 am reactants |
| 20. Extra notes:The course book lacks the problems which affect the educational process. These problems include a large number of students in each stage, a diminution of instruments, and an absence of appropriate rooms for lecturers to develop themselves. Finally, the department of geology absence of financial support to carry out scientific trips and field courses in a typical situation. |
| **21. Peer review** Assistant Prof. Dr. Hikmat S. Mustafa Al-Jaleel.‌‌  |