University of Belgrade, Technical Faculty in Bor

30th International Conference Ecological Truth & Environmental Research 2023

Proceedings

Editor
Prof. Dr Snežana Šerbula

University of Belgrade, Technical Faculty in Bor

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PREFACE

The 30th international conference Ecological Truth & Environmental Research – EcoTER'23 kept three areas in focus: ecology, environmental protection and sustainable development. The conference will be held on Mt Stara Planina in hotel Stara Planina, Serbia, 20–23 June 2023. The monograph is published on the occasion of the 30th anniversary of the conference. On behalf of the scientific and organizing committee, it is a great honor and pleasure to wish all the participants a warm welcome to the conference.

The monograph is published on the occasion of the 30th anniversary of the conference.

We hope to convey the message of the conference, which is that a transformation of attitudes and behavior would bring the necessary changes. This is also an opportunity for the participants who are experts in this field to exchange their experiences, expertise and ideas, and also to consider the possibilities for their collaborative research.

The 30th international conference Ecological Truth & Environmental Research – EcoTER'23 is organized by the University of Belgrade, Technical Faculty in Bor, and co-organized by the University of Banja Luka, Faculty of Technology, the University of Montenegro, Faculty of Metallurgy and Technology – Podgorica, the University of Zagreb, Faculty of Metallurgy – Sisak, the University of Pristina, Faculty of Technical Sciences – Kosovska Mitrovica and the Association of Young Researchers, Bor.

These Proceedings 103 papers from the authors coming from the universities, research institutes and industries in 11 countries: Australia, USA, Brazil, Spain, Portugal, Libya, Italy, Bulgaria, Bosnia and Herzegovina, North Macedonia, and Serbia.

As a part of this year's conference, the 5th Student Session – EcoTERS'23 is being held. We appreciate the contribution of the students and their mentors who have also participated in the conference.

The support of the Gold donor and their willingness and ability to cooperate has been of great importance for the success of the EcoTER'23. The organizing committee would like to extend their appreciation and gratitude to the Gold donor of the conference for their donation and support.

We appreciate the effort of all the authors who have contributed to these Proceedings. We would also like to express our gratitude to the members of the scientific and organizing committees, reviewers, speakers, chairpersons and all the conference participants for their support to the EcoTER'23. Sincere thanks go to all the people who have contributed to the successful organization of the EcoTER'23.

Prof. Snežana Šerbula,

President of the scientific and organizing committee

TABLE OF CONTENTS

Plenary Lecture

Invited Lectures

Conference Papers

Environmental monitoring and impact assessment

Urban and industrial ecology

Air, water and soil pollution, prevention and control

Protection and preservation of natural resources

Student Section

30th International Conference Ecological Truth & Environmental Research
20–23 June 2023, Serbia

ADSORPTION ISOTHERMS FOR COPPER IONS BIOSORPTION ONTO ONION PEELS

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Abstract

Langmuir, Freundlich, and Temkin isotherm models were used to study the equilibrium and mechanism of biosorption of copper ions onto onion peels under batch conditions. Isotherm parameters were calculated from the line graphs according to each model. The results obtained on the basis of correlation coefficients, show that the Freundlich isotherm model (R^2 = 0.964) is in good agreement with the analyzed experimental data. This model assumes that the surface energy of the adsorbent is heterogeneous, strong binding sites are occupied first, and that the binding energy decreases as the number of occupied adsorbent sites increases.

Keywords: Adsorption isotherms, copper ions, onion peels, biosorption.

INTRODUCTION

Water is making up more than 70% of the Earth's surface, and it is our most valuable natural resource, without which life would not be possible [1]. However, as a result of the continuous population growth, agricultural activities, industrialization, and other geological, environmental, and global changes, water pollution is increasing and, in many parts of the world, safe drinking water is not available [2]. Due to the great importance of water for our everyday life, the need for continuous improvement and preservation of water quality is constantly increasing [3]. Water whose physical, chemical, or biological properties have been altered by the presence of certain substances that make it unsafe, for example, consumption, is considered wastewater [4].

Many industries, such as metallurgy processing plants, metal finishing plants, electronic industry, electroplating, phytopharmaceutical plants, and many others, release heavy metals along with their wastewater, polluting the environment [5].

Many biological waste materials, such as fungi, algae, peat, yeasts, and different agricultural wastes have been tested as potential adsorbents for heavy metal ions adsorption from water solutions [6].

Adsorption isotherms are used to obtain information about the mechanism of the adsorption process, and the maximum adsorption capacity. There are several adsorption isotherm models that are usually used in relevant literature to describe the adsorption equilibrium, such as Langmuir, Freundlich, Temkin, Sips, Brunauer, Emmett and Teller (BET) model [7,8].

MATERIALS AND METHODS

Adsorption isotherm data was obtained by performing the following experiment: 0.5 g of onion peels (granulation -1 + 0.4 mm) was brought into contact with 50 mL of synthetic solutions containing different initial concentrations of copper ions, ranging from 50 to 500 mg dm^{-3}. The suspension was stirred by a magnetic stirrer for 60 min, considered a process time long enough to reach the equilibrium between phases [9]. The suspension was then filtered and the filtrate was analysed on the residual amount of copper ions.

RESULTS AND DISCUSSION

Adsorption isotherm for copper ions biosorption onto onion peels

The obtained adsorption isotherm for copper ions biosorption onto onion peels is shown in Figure 1.

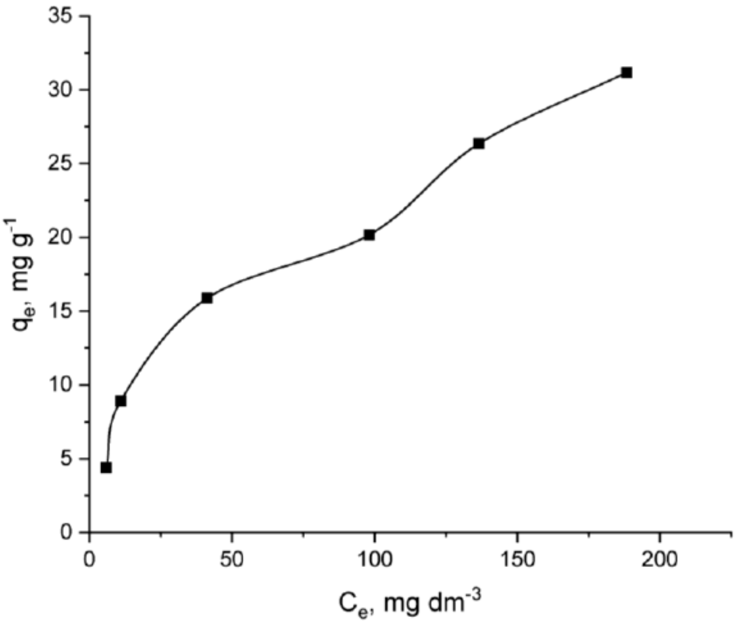

***Figure 1** Adsorption isotherm for copper ions biosorption onto onion peels*

According to Figure 1, the adsorption capacity increases with increasing the concentration of copper ions.

Langmuir model

The Langmuir model assumes that adsorption takes place in a monolayer and that the surface of the adsorbent consists of active sites with constant adsorption energy [10].

The Langmuir model can be written by the following equation:

$$q_e = \frac{q_m K_L C_e}{1 + K_L C_e} \quad (1)$$

Linearisation of Eq. (1) the following equation is obtained:

$$C_e / q_e = \frac{1}{K_L q_m} + \frac{1}{q_m} C_e \quad (2)$$

where C_e is the equilibrium concentration of metal ions (mg dm^{-3}), q_e is the equilibrium adsorption capacity (mg g^{-1}), q_m is the maximum adsorption capacity (mg g^{-1}) and K_L (dm^3 g^{-1}) is the Langmuir equilibrium constant.

Graphical dependence of C_e/q_e in function of C_e gives the straight-line with the slope $1/q_m$ and the intercept $1/K_L q_m$ which is shown in Figure 2.

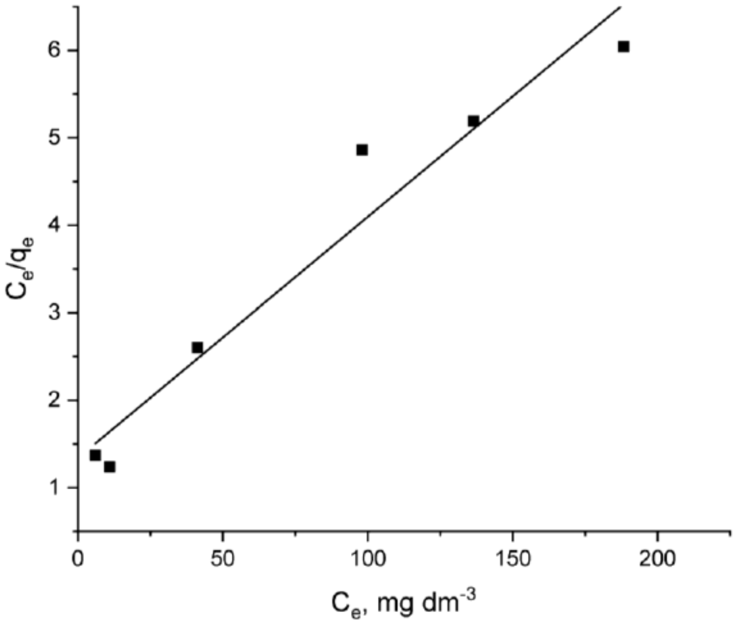

Figure 2 *Langmuir adsorption isotherm model for copper ions biosorption onto onion peels*

Freundlich model

The Freundlich adsorption isotherm model is based on the assumptions that the surface energy of the adsorbent is heterogeneous, that strong binding sites are occupied first, and that binding energy decreases with the increase in the number of occupied adsorption sites [10].

This model is represented by the following equation:

$$q_e = K_f C_e^{1/n} \quad (3)$$

Linear form of Eq. (3) is given as:

$$\log q_e = \log K_F + \frac{1}{n} \log C_e \quad (4)$$

where C_e is the equilibrium concentration of copper ions in the solution (mg dm^{-3}); q_e is the adsorbent capacity defined as mass of the adsorbed metal per unit mass of the adsorbent (mg g^{-1}) at equilibrium; K_F is the Freundlich equilibrium constant ((mg g^{-1}) (dm^3 mg^{-1})$^{1/n}$), and $1/n$ is the coefficient of heterogeneity in the Freundlich adsorption isotherm equation.

Graphical dependence of *log* q_e in function of *log* C_e gives the straight line, with the slope $1/n$ and the intercept K_F which is shown in Figure 3.

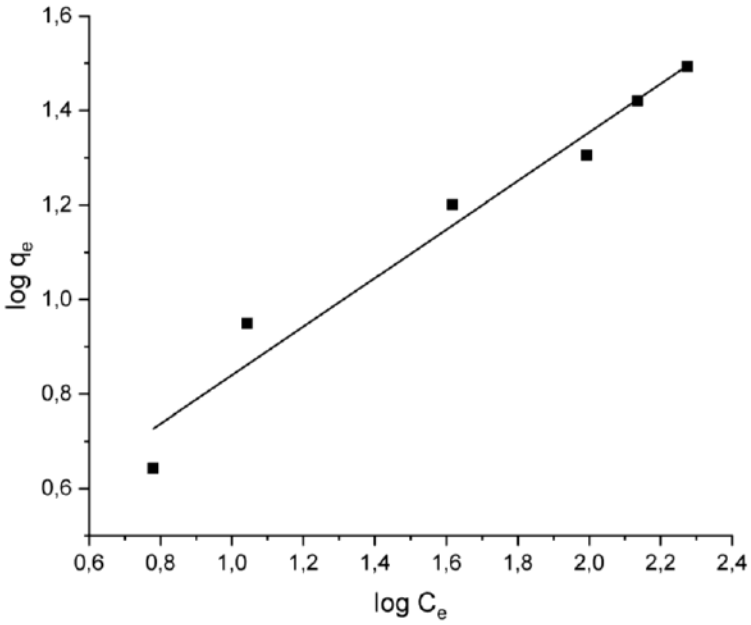

Figure 3 *Freundlich adsorption isotherm model for copper ions biosorption onto onion peels*

Temkin model

Temkin adsorption isotherm model is based on the assumption that, due to the interactions between the adsorbent and the absorbate, the adsorption heat of all adsorbed molecules decreases linearly with the degree of surface coverage, as well as that the binding energy distribution is uniform, up to some maximum energy [11].

Temkin isotherm model is represented by the following equation:

$$q_e = B \ln (K_T C_e) \tag{5}$$

Linear form of the Eq. (5) is given as:

$$q_e = B \ln K_T + B \ln C_e \tag{6}$$

where $B = RT/b$ is the Temkin constant, which refers to the adsorption heat (J mol^{-1}); b is the variation of adsorption energy (J mol^{-1}); R is the universal gas constant (J mol^{-1} K^{-1}); T is the temperature (K); K_T is the Temkin equilibrium constant (dm^3 g^{-1}); q_e is the adsorption capacity defined as mass of the adsorbed metal per unit mass of the adsorbent (mg g^{-1}) at equilibrium; C_e is the equilibrium concentration of copper ions in the solution (mg dm^{-3}). Constants B and K_T can be determined from the graph $q_e = f(ln\ C_e)$ (Figure 4), where B is the slope, and K_T the intercept.

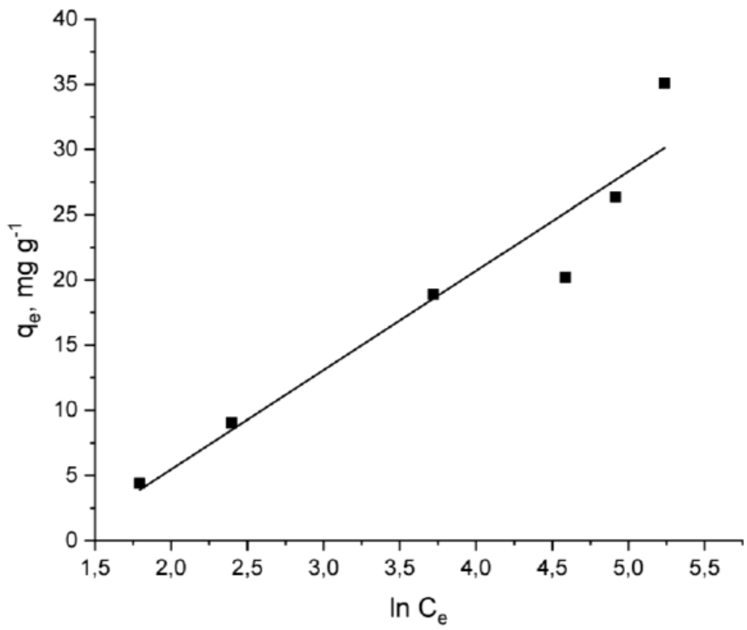

Figure 4 *Temkin adsorption isotherm model for copper ions biosorption onto onion peels*

The obtained experimental data, shown on Figure 1, was fitted using Langmuir, Freundlich and Temkin adsorption isotherm models. Equilibrium parameters for the considered models were determined using the Equations (2), (4) and (6), and, along with the correlation coefficient R^2, are given in Table 1.

Table 1 *Obtained parameters for Langmuir, Freundlich and Temkin adsorption isotherm models for copper ions biosorption onto onion peels*

Langmuir				Freundlich			Temkin		
K_L dm^3 mg^{-1}	q_{exp} mg g^{-1}	q_m mg g^{-1}	R^2	K_F	1/n	R^2	B J mol^{-1}	K_T dm^3 g^{-1}	R^2
0.021	31.16	36.28	0.949	2.117	1.945	0.964	7.613	-9.759	0.917

CONCLUSION

Onion peels were used as a biosorbent for copper ions biosorption from synthetic copper ion solutions. The adsorption equilibrium data were analysed using the Langmuir, Freundlich, and Temkin adsorption isotherm models. Obtained results indicate that the Freundlich model best fits the analysed experimental data, with the correlation coefficient R^2 = 0.964. This means that the surface energy of the adsorbent is heterogeneous, strong binding sites are occupied first, and that binding energy decreases with the increase in the number of occupied adsorption sites.

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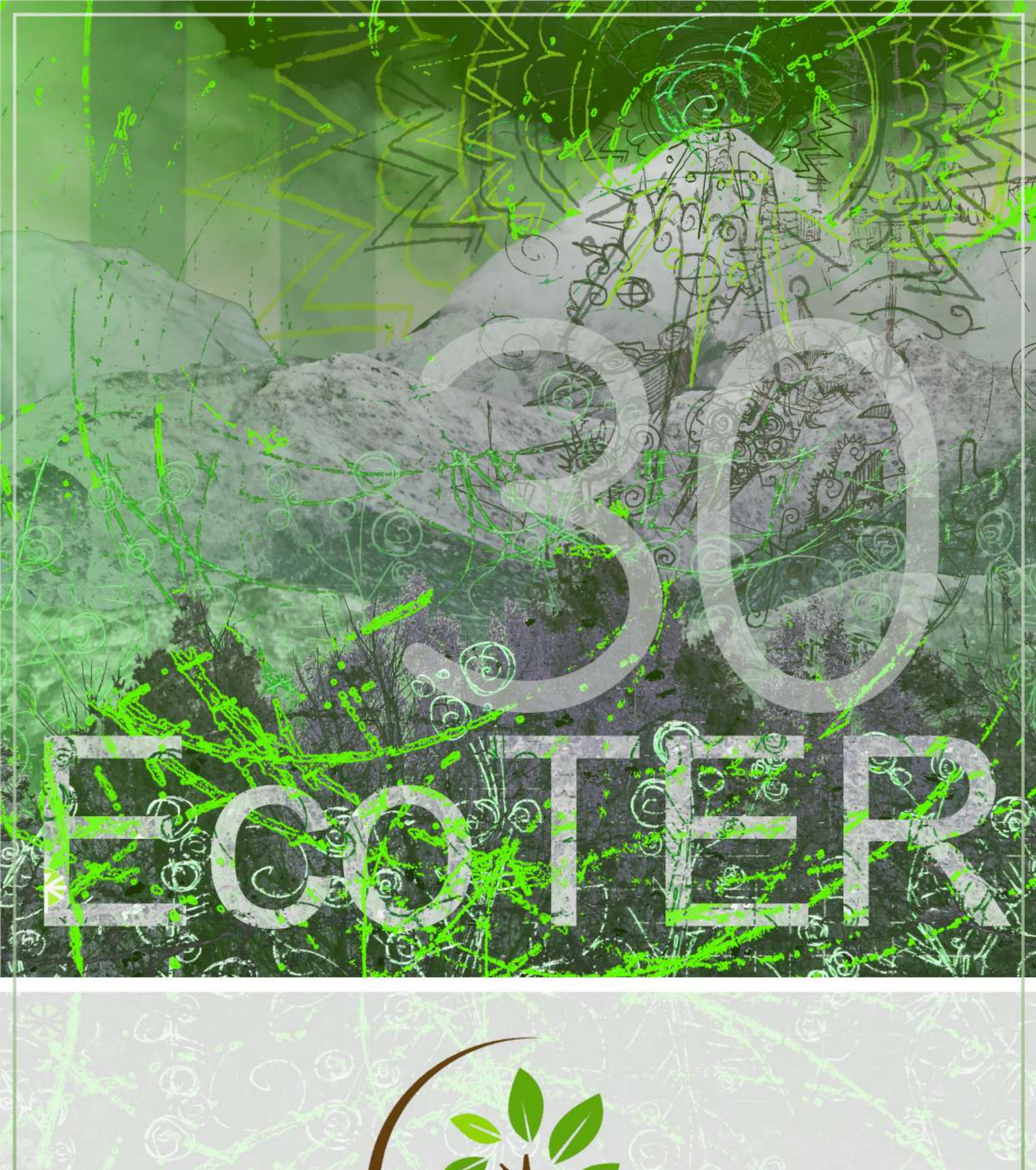

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